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1. X **Patent** ***Document No.** 8-227431
***Country Code** JP
***Publication Date** 3/9/96
***Language** Japanese
No. of Pages _____ *(filled by STIC)*

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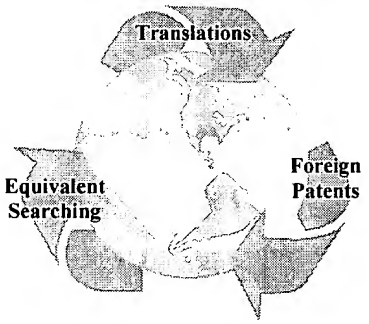

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CLAIMS

[Claim(s)]
[Claim 1] By the CAD system, each side of the input figure corresponding to a mask pattern The process which is the LISA IJINGU method of the mask pattern which the exterior or the interior of the input figure is made to carry out a parallel displacement, and obtains an enlarged-view form or a reduction figure, and judges whether the aforementioned input figure contains an oblique side, The process which judges whether the peak is influenced of an oblique side for every peak of the input figure when the input figure contains the oblique side, The process which makes each endpoint corresponding to the peak at the time of carrying out the parallel displacement of the side of the couple of the input figure which faces across the peak to the interior or the exterior of a figure when the peak of an input figure is influenced of an oblique side the peak of a temporary figure with the peak, When the peak of an input figure is not influenced of an oblique side The process which carries out the parallel displacement of the side of the couple of the input figure which faces across the peak to the exterior or the interior of a figure, respectively, and makes the intersection of each side by which the parallel displacement was carried out, or the intersection of the extension wire of each side by which the parallel displacement was carried out the peak of the temporary figure to the peak of an input figure, The LISA IJINGU method of the mask pattern characterized by including the process which connects each peak of the obtained temporary figure and generates a temporary figure, and the process which carries out the OR operation of the generated temporary figure.
[Claim 2] The LISA IJINGU method of the mask pattern according to claim 1 characterized by what is judged by whether the oblique side is contained in the side of the couple which faces across each peak where each peak of an input figure adjoins [whether it is influenced of an oblique side, and] the peak.
[Claim 3] The LISA IJINGU method of a mask pattern according to claim 1 that each peak of an input figure is characterized by judging whether it is influenced of an oblique side based on the angle of each peak contiguous to the peak.
[Claim 4] The LISA IJINGU method of a mask pattern according to claim 1 that each peak of an input figure is characterized by judging whether it is influenced of an oblique side based on the sum of the angle of the peak, the angle of each peak contiguous to the peak, and the angle of each of each peak which adjoins the angle of the peak.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates the mask pattern carried out using a CAD (Computer Aided Design) system to expansion data processing and the LISA IJINGU method which carries out reduction data processing.
[0002]
[Description of the Prior Art] LSI is designed by the CAD system with large-scale high integration of LSI now. Especially, the figure calculation function must not be in the artwork system for a mask pattern.
[0003] As one of the figure operations, LISA IJINGU (resizing) which performs expansion and reduction of a mask pattern is used for the design rule verification about the minimum spacing and the minimum width of face of a mask pattern, extraction of the field which can be wired, a notch, removal of a salient, etc. LISA IJINGU in this case is operation which only the change width of face specified the exterior or inside the figure carries out the parallel displacement of each of that side by making a mask pattern into an input figure, and obtains an enlarged-view form or a reduction figure, and is not operation of obtaining a similar figure.
[0004] For example, operation of only the specification width of face d making the parallel displacement of each side of the input figure 30 carrying out outside, respectively as shown in drawing 18 (b) by making a mask pattern as shown in drawing 18 (a) into the input figure 30, and obtaining enlarged-view form 31 is LISA IJINGU (expansion operation), and as shown in drawing 18 (c), it differs from operation of making each side of the input figure 30 expanding, respectively, and obtaining a similar figure 32.
[0005] By the expansion operation (expanding) in LISA IJINGU As are shown in drawing 19 (a), and the external field 33 in the range of the specification width of face d also makes it the fundamental concept to treat as the interior of a figure from each side of the input figure 30 and a reduction operation (shrinking) shows to drawing 19 (b) It is making into the fundamental concept to also treat the internal field 34 which is in the range of the specification width of face d from each side of an input figure as the exterior of a figure. If the interior angle of the peak in the input figure 30 is a salient (it is smallness from pi) in the case of the expansion operation, the peak will become radii-like by expanding only the specification width of face d.
[0006] For example, as shown at drawing 19 (c) in the case of an expansion operation, although peak 30a from which the interior angle in the input figure 30 turned into a salient disappears when each sides 30b and 30c which constitute the peak carry out a parallel displacement, respectively, when the sector interpolation figure 35 interpolates, it becomes radii-like. However, in the mask pattern, difficult, from the bird clapper, handling adds the additional figure 36 surrounded by each tangent and radii portion of ends of a radii portion in the sector interpolation figure 35 to the sector interpolation figure 35, and if the circular sector interpolation figure 35 exists, as shown in drawing 19 (d), as shown in drawing 19 (e), it is changing the sector interpolation figure 35 into the square interpolation figure 37. Thereby, enlarged-view form (LISA IJINGU figure) 31 shown in drawing 19 (f) are obtained.
[0007] The reduction figure (LISA IJINGU figure) 38 shown in drawing 19 (g) is obtained by treating the square interpolation figure from which the additional figure surrounded by each tangent and radii portion of ends of a radii portion in a sector interpolation figure was similarly added to the sector interpolation figure in the reduction operation and which it consisted of as the exterior of a figure.
[0008] Thus, the obtained LISA IJINGU figure is used for the rule verification about the minimum spacing and the minimum width of face of a mask pattern of IC, extraction of the field which can be wired, a notch, removal of a salient, etc.
[0009] While design rule verification of minimum spacing judges whether it is mutually separated only from the minimum spacing d two or more mask patterns were specified to be, when minimum spacing d is not being filled, it is processing which specifies the portion. for example, as shown in drawing 20 (a), when the input figures 41 and 42 equivalent to the mask pattern of the couple which became parallel to mutual verify whether minimum spacing d is satisfied As are shown in drawing 20 (b), and an expansion operation is carried out by one half of the width of face of minimum spacing d and each input figures 41 and 42 are shown in drawing 20 (c) When the LISA IJINGU figures 43 and 44 by which the expansion operation was carried out have lapped mutually, each input figures 41 and 42 are specified in the lap portion 45 as what has not satisfied minimum spacing d.
[0010] The minimum width-of-face verification for example, the figure 46 equivalent to the mask pattern of a configuration as shown in drawing 21 (a) As it is the processing which verifies whether the minimum width-of-face size is satisfied, the reduction operation of the input figure 46 equivalent to a mask pattern is carried out by one half of the width of face of the minimum width-of-face size d and it is shown in drawing 21 (b) If the LISA IJINGU figure 47 by which the reduction operation was carried out is divided into two or more figures 47a and 47b, as shown in drawing 21 (c), the separated portion 48 specifies as what has not satisfied the minimum width-of-face size d.
[0011] Extraction of the field which can be wired like [as shown in drawing 22 (a)] the field already wired As shown in drawing 22 (b), three input figures 51, 52, and 53 which show the field whose wiring is impossible As only the size d equal to the sum of the one half and wiring minimum spacing of wiring width of face carries out an expansion operation,

respectively and is shown in drawing 22 (c), each LISA IJINGU figures 54 and 55 by which the expansion operation was carried out, and fields 57 other than 56 are extracted as a field which can be wired.
[0012] The width-of-face size of a notch [in / a mask pattern / with removal of a notch or a salient] (interval of a notching portion), Or when the width of face of a salient has not satisfied the minimum size, as a part for the notch portion or a height is removed and it is shown in drawing 23 (a) In the case of the input figure 61 which has notch 61a, with one half of the sizes of the minimum width-of-face size d of notch 61a, the expansion operation of the figure 61 is carried out, and as shown in drawing 23 (b), the LISA IJIGU figure 62 by which the expansion operation was carried out is obtained. Then, as shown in drawing 23 (c), only the same size (d/2) carries out the reduction operation of the LISA IJINGU figure 62 by which the expansion operation was carried out. When the width-of-face size of notch 61a has not satisfied the minimum width-of-face size d, notch 61a will be removed by the LISA IJINGU figure 63 obtained according to a reduction operation.
[0013] With increase of the number of figures by the large-scale integration of IC, help processing becomes difficult and the figure operation which processes the figure group which constitutes the mask pattern of IC is processed by the CAD system. For example, the method of creating automatically the overlap between the contiguity patterns to which the computer was applied is indicated by JP,3-9474,A, and the method of creating the mask data for semiconductor manufacture using CAD data is indicated by JP,6-19110,A.
[0014] Moreover, the various proposals of the high-speed algorithm are made from the need of processing a huge number of figures at the figure operation.
[0015] For example, the OR operation which is one of the figure operations is reported to "A Concurrent pattern Operation Algorithm for VLSI Mask Data (Proc.18 th Design Automation Conference, 1981)" (let this report be a conventional method 1 hereafter). An OR operation is an operation which extracts the boundary line which separates the field with which one or more figures have lapped, and the field where one does not have a figure, and by this report, if the total number of the peaks of the input figure group before OR-operation execution is set to n, it can obtain the figure group after an OR operation by the calculation complexity of O (n log n).
[0016] An example of an OR operation is shown in drawing 24 . As shown in drawing 24 (a), in carrying out the OR operation of the square small input figure 65, the square big input figure 66, the input figure 67 of the rectangle to which the part lapped with the input figure 66 of this big square, and the input figure 68 that shows opening of a still smaller rectangle, it vectorizes all the sides of each input figures 65-68. In this example, each side is vectorized so that the interior of a figure may become right-hand side for convenience, therefore each side of the input figure 68 of opening is vectorized so that the interior of opening may become left-hand side. And the number of laps of the input figures 65-68 is obtained from the sense of a vector, and one or more portions are taken out for the number of laps. Usually, the number of laps of one input figure which is not opening is 1, and the outside of a figure is 0. Moreover, in the portion with which two input figures have lapped, the number of laps is 2 and, as for opening, the number of laps is set to -1. As a result of an OR operation, the figure shown in drawing 24 (b) is obtained, and the input figure 68 of opening which became negative disappears.
[0017] Moreover, expansion and the reduction operation of a figure are reported to "An O(n log n) algorithm forLSI layout resizing problems (85 ISCAS '1985)" (let this report be a conventional method 2 hereafter). In this report, a LISA IJINGU figure is obtained by performing separately expansion of the direction of X, expansion of reduction and the direction of Y, or reduction.
[0018] For this reason, theoretically, when the total number of the peaks of an input figure group is set to n, although it can process in the calculation complexity of O (n log n), since expansion with the direction of X and the direction of Y or reduction is carried out separately, there is a problem that improvement in the speed of the processing time is difficult.
[0019] And since it is aimed at the figure which consists only of the level side and the perpendicular side parallel to the direction of X, and the direction of Y fundamentally, although the input figure which has angle (45 degrees or 135 degrees) of an oblique side to the X-axis is also possible for LISA IJINGU processing, processing of an oblique side becomes complicated. For example, as shown in drawing 25 (a), neither the input figure 70 which has the short level side 73 among the oblique sides 71 and 72 of a couple, nor a LISA IJINGU figure exact as shown in drawing 25 (b) rather than the length of the level side 73 and the perpendicular side 76, when carrying out the expansion operation of the input figure 77 which has the short perpendicular side 76 between an oblique side 74 and the level side 75 by major-change width of face is obtained. The exact expansion data-processing figure of each figure will be disappeared by the level side 73 and the side corresponding to the perpendicular side 76, respectively, as an alternate long and short dash line shows to drawing 25 (a) and (b). In order to obtain such an exact expansion data-processing figure, intersection calculation of intersection calculation of the oblique sides 71 and 72 of the couple which faces across the level side 73, the oblique side 74 which faces across the perpendicular side 76, and the perpendicular side 75 is needed for expansion processing of the direction of X of each side, and the direction of Y further, respectively. Therefore, it is not easy to be unable to obtain an exact LISA IJINGU figure, if such complicated processing is not added, but to accelerate the processing time.
[0020] Furthermore, in order to obtain a LISA IJINGU figure for the input figure which becomes "the enlarging-or-contracting technique (Information Processing Society of Japan research report DA 43-4 and 1988-7) of an LSI pattern including the arbitrary angle side" from the arbitrary angle side, the method of obtaining a LISA IJINGU figure is indicated by generating a middle temporary figure and carrying out the OR operation of the generated temporary figure (let this be a conventional method 3 hereafter).
[0021] The flow chart of this conventional method 3 is shown in drawing 26 . In this conventional method 3, first, if the change width of face d is read (step 26- of drawing 26 (a) it is the same as that of 1 and the following), the input figure group S which consists of two or more input figures will be read (Step 26-2). And the OR operation of the read input figure group S is carried out (Step 26-3).
[0022] When a mask pattern is inputted as a figure group constituted by two or more figures, expansion data processing or before carrying out reduction data processing, an OR operation is needed in a mask pattern. For example, if expansion data processing of it is carried out without carrying out OR-operation processing when the mask pattern 80 shown in drawing 27 (a) is inputted as input figures 81, 82, and 83 of three rectangles, as shown in drawing 27 (b), as shown in drawing 27 (c) all -- an input -- a figure -- 81 -- 82 -- 83 -- expansion -- data processing -- carrying out -- having -- a sake -- each -- an input -- a figure -- 81 -- 82 -- 83 -- receiving -- an enlarged view -- type -- 81 -- ' -- 82 -- ' -- 83 -- ' -- obtaining -- having -- these -- an

enlarged view -- type -- 81 -- ' -- 82 --' -- 83 -- ' -- an OR operation -- processing -- carrying out -- even if -- being exact -- LISA -- IJINGU -- a figure -- For this reason, when a mask pattern is inputted by the figure group which consisted of two or more figures, an OR operation is needed to the input figure group.
[0023] Then, a temporary figure is generated to all the N input figures, using the number of figures after OR-operation processing of an input figure group as N (Step 26-4) (Step 26-5 to 26-18).
[0024] On the occasion of generation of a temporary figure, the number of the peaks of the input figure F is set to M, using the n-th input figure as F (Step 26-6) (Step 26-7), all the peaks are oriented as a peak train, and each side is vectorized (Step 26-8). And the peak of a temporary figure is generated to all the peaks (Step 26-9 to 26-16).
[0025] The peak of a temporary figure sets to W the peak which adjoins the peak which adjoins an opposite side with the direction of the vector of V and its peak V in the m-th peak of the peak train in the input figure F in U and the direction of a vector of the peak V (Step 26-10), and LISA IJINGU judges an expansion operation or a reduction operation (Step 26-11). And when LISA IJINGU is an expansion operation, the interior angle of the peak V judges a salient (it is smallness from pi), and a reentrant angle (it is size from pi) (Step 26-12). When the interior angle of the peak V is a salient, let the intersection of each vectors acquired in the sides UV and VW of the couple which faces across the peak V by carrying out the parallel displacement only of the change width of face d to the exterior of an OR-operation figure, respectively, or those extension wire be the peak of a temporary figure (Step 26-14). The generation method of the peak of such a temporary figure is made into Process A.
[0026] moreover, when LISA IJINGU is an expansion operation and the interior angle of the peak V is a reentrant angle the peak -- V -- inserting -- a couple -- the side -- UV -- and -- VW -- respectively -- change -- width of face -- d -- only -- an OR operation -- a figure -- the exterior -- a parallel displacement -- carrying out -- obtaining -- having -- each -- a vector -- U'V -- ' -- and -- V"W -- ' -- the peak -- V -- corresponding -- each -- an endpoint -- V -- ' -- and -- V -- " -- The peak V of an input figure is registered as the peak of a temporary figure in order of V', V, and V", respectively (Step 26-15). The generation method of the peak of such a temporary figure is made into Process B.
[0027] When LISA IJINGU is a reduction operation, the interior angle of the peak V judges a salient (it is smallness from pi), and a reentrant angle (it is size from pi) (Step 26-13), and when the interior angle of the peak V is a reentrant angle, contrary to the case of an expansion operation according to Process A Let the intersection of the vectors acquired in the sides UV and VW of the couple which faces across the peak V by carrying out the parallel displacement only of the change width of face d to the interior of an OR-operation figure, respectively, or those extension wire be the peak of a temporary figure (Step 26-14). When LISA IJINGU is a reduction operation and the interior angle of the peak V is a salient a process -- B -- the peak -- V -- inserting -- a couple -- the side -- UV -- and -- VW -- respectively -- change -- width of face -- d -- only -- an OR operation -- a figure -- the interior -- a parallel displacement -- carrying out -- obtaining -- having -- each -- a vector -- U'V -- ' -- and -- V"W -- ' -- the peak -- V -- corresponding -- an endpoint -- V -- ' -- and -- V -- " -- The peak V of an OR-operation figure is registered as the peak of a temporary figure in order of V', V, and V", respectively (Step 26-15).
[0028] A temporary figure is generated by carrying out generation of such the peak of a temporary figure to all the figures produced by the OR operation (Step 26-17), and connecting in order the peak where the temporary figure was registered (Step 26-18). And the OR operation of the generated temporary figure is carried out (Step 26-19), and the figure by which the OR operation was carried out is outputted as a LISA IJINGU figure S (Step 26-20). Although the temporary figure will be crossed by the side, it is made an exact LISA IJINGU figure by the OR operation.
[0029] In this conventional method 3, as shown in drawing 28 (a), when the number of the peaks is the input figure 84 of 18, as shown in drawing 28 (b), let the number of the peaks be the temporary figure 85 of 32, for example.
[0030] In such an operation art, by processing of the any 1 direction of the direction of X, or the direction of Y, even if the oblique side is included, an exact LISA IJINGU figure without an error can be obtained. Moreover, each peak of an OR-operation figure is processed in order along the side, and in order to end by going around an OR-operation figure, it can process easily by the trouble of O (n). Furthermore, the calculation complexity of O (n log n) is realizable like the case of the OR operation of a conventional method 2 by adopting a conventional method 1 as the OR operation carried out for neighboring intersection processing. And since internal data structure becomes a linear list, it becomes possible to process rather than the case where the in-house data is not a linear list, like a conventional method 2 at high speed.
[0031]
[Problem(s) to be Solved by the Invention] In a conventional method 3, since a temporary figure is generated by the calculation complexity of O (n log n), the time which the OR operation of a temporary figure takes the machine time of the whole processing is almost the case. However, in order to consider as the process B which the peak of an input figure judges a salient or a reentrant angle, and considers as the process A which generates only the one peak of a temporary figure on the occasion of generation of the peak of a temporary figure, or generates the three peaks When the peak of an input figure is a reentrant angle (or salient) at the time of an expansion operation (or reduction operation), three will be generated as the peak of the temporary figure corresponding to the peak. Consequently, the number of the peaks of a temporary figure increases and there is a problem that the OR operation of a temporary figure takes a long time.
[0032] As a method of cutting down the total number of the peaks of a temporary figure, generating the peak of one temporary figure to each peak of an input figure is also considered by applying the process A of a conventional method 3 for generation of the peak of a temporary figure. Hereafter, this is made into a conventional method 4 and the flow chart is shown in drawing 29 . In the flow chart of drawing 29 , the above-mentioned process A generates all the peaks of a temporary figure (Step 29-11), and other steps are the same as that of the flow chart of a conventional method 3 shown in drawing 26 .
[0033] Only the specification width of face d carries out the parallel displacement of the two sides which face across the peak, and the generation method of each peak of the temporary figure in this conventional method 4 makes the intersection of each side by which the parallel displacement was carried out, or the intersection of the extension wire of each side by which the parallel displacement was carried out the peak of a temporary figure. Therefore, the one peak of a temporary figure is generated to the one peak of an input figure. And a temporary figure is generated by connecting the peak of a temporary figure in order. Therefore, the oblique side is contained in the input figure, moreover, when there are many peaks of an input figure which became a reentrant angle (at or the time of a reduction operation salient) at the time of an expansion operation,

the total number of the peaks of a temporary figure can be lessened compared with a conventional method 3, and the time which an OR operation takes is also shortened.
[0034] However, as shown in drawing 30 (a), when the input figure 86 which consists of two or more squares has an oblique side, the expansion operation figure 87 shown with an alternate long and short dash line is obtained, and since partial 87a which should be treated as the interior of a figure is originally recognized as the exterior of a figure, the mistaken temporary figure is generated. Also in the case of the input figure 88 which similarly has an oblique side as shown in drawing 30 (b), the mistaken temporary figure partial 89a by which the expansion operation figure 89 should be treated as the interior of a figure has been recognized to be as the exterior of a figure is generated.
[0035] this invention solves such a problem, and the purpose is in offering the LISA IJINGU method of the mask pattern which can obtain an exact LISA IJINGU figure at high speed, when the figure which constitutes the mask pattern of IC contains the oblique side.
[0036]
[Means for Solving the Problem] The LISA IJINGU method of the mask pattern of this invention By the CAD system, each side of the input figure corresponding to a mask pattern The process which is the LISA IJINGU method of the mask pattern which the exterior or the interior of the input figure is made to carry out a parallel displacement, and obtains an enlarged-view form or a reduction figure, and judges whether the aforementioned input figure contains an oblique side, The process which judges whether the peak is influenced of an oblique side for every peak of the input figure when the input figure contains the oblique side, The process which makes each endpoint corresponding to the peak at the time of carrying out the parallel displacement of the side of the couple of the input figure which faces across the peak to the interior or the exterior of a figure when the peak of an input figure is influenced of an oblique side the peak of a temporary figure with the peak, When the peak of an input figure is not influenced of an oblique side The process which carries out the parallel displacement of the side of the couple of the input figure which faces across the peak to the exterior or the interior of a figure, respectively, and makes the intersection of each side by which the parallel displacement was carried out, or the intersection of the extension wire of each side by which the parallel displacement was carried out the peak of the temporary figure to the peak of an input figure, It is characterized by including the process which connects each peak of the obtained temporary figure and generates a temporary figure, and the process which carries out the OR operation of the generated temporary figure, and the above-mentioned purpose is attained by that.
[0037] In addition, it is desirable to judge based on the sum of the angle of the peak, the angle of each peak contiguous to the peak, and the angle of each of each peak which adjoins the angle of the peak based on the angle of each peak contiguous to whether the oblique side is contained in the side of the couple which faces across each peak where each peak of an input figure adjoins [whether it is influenced of an oblique side and] the peak, and its peak.
[0038]
[Function] By the LISA IJINGU method of the mask pattern of this invention, first, each side of the input figure equivalent to a mask pattern, when it judges whether the oblique side is contained and the oblique side is contained, each peak of an input figure judges whether the influence of an oblique side is received. And in the case of the peak which is not influenced of an oblique side, in the case of an expansion operation, in the case of the exterior of a figure, and a reduction operation, the parallel displacement of the side of the couple which faces across the peak is carried out to the interior of a figure, respectively, and let the intersection of each side by which the parallel displacement was carried out, or the intersection of the extension wire of each side be the peak of a temporary figure. Therefore, in this case, the one peak of a temporary figure is generated to the one peak. When the peak is influenced of an oblique side, in the case of an expansion operation, in the case of the exterior of a figure, and a reduction operation, the parallel displacement of the side of the couple which faces across the peak is carried out to the interior of a figure, respectively, and three of each of each endpoint corresponding to the peak and the peaks of the input figure of a basis in each side by which the parallel displacement was carried out are set up as the peak of a temporary figure.
[0039] A setup of the peak of a temporary figure obtains a LISA IJINGU figure by connecting each peak, and generating and carrying out the OR operation of the temporary figure.
[0040] In the mask pattern of IC, if either of the sides of a couple is an oblique side, respectively, although each peak in an input figure will be made into the thing which is faced across each peak contiguous to the peak and which is influenced of an oblique side, since an oblique side is used for a part of figure, it is rare that the process which generates the peak of three temporary figures is adopted, and the total number of the peaks of a temporary figure can usually, be cut down. The time which a subsequent OR operation takes can be shortened and the rapidity of processing is raised.
[0041] Moreover, by judging whether the peak of an input figure is influenced of an oblique side based on the angle of each peak contiguous to the peak, that the process which generates the peak of three temporary figures is adopted decreases, and the rapidity of graphics processing is raised. Furthermore, by judging whether the peak of an input figure is influenced of an oblique side based on the sum of the angle of the peak, the angle of each peak contiguous to the peak, and the angle of each of each peak which adjoins the angle of the peak, the scope of the process which generates the peak of three temporary figures is limited further, and graphics processing is accelerated further.
[0042]
[Example] Hereafter, the example of this invention is explained in detail based on a drawing.
[0043] The LISA IJINGU method of the mask pattern of this invention is CAD (Computer Aided Design) because of verification of the mask pattern of LSI etc. When only the change width of face specified the exterior or inside the figure carries out the parallel displacement of each side of the input figure by making a mask pattern into an input figure by the system, it is the method of obtaining an enlarged-view form or a reduction figure.
[0044] Drawing 1 is a flow chart which shows an example of the LISA IJINGU method of the mask pattern of this invention. in this example, first, as shown in drawing 1 (a), the mask pattern inputted into a CAD system is inputted into expansion data processing or the change width of face d of each side at the time of carrying out reduction data processing (LISA IJINGU processing) (one to step 1 reference of drawing 1 , and the following -- the same) In this case, positive and change width of face when reducing are made negative for the change width of face when expanding an input figure.
[0045] Next, the data of the mask pattern of LSI set as the object of LISA IJINGU is inputted with X-Y coordinate (Step

1-2).
[0046] Drawing 2 (a) shows an example of the mask pattern inputted. This mask pattern 10 has the oblique side section 11 which inclines at 45 degrees in the center section, and the horizontal level 12 of the shape of an oblong rectangle has extended horizontally from the edge of the oblique side section 11 top. The rectangle section 13 of the shape of a square with a bigger length of one side than the width-of-face size of a horizontal level 12 is following the point of this horizontal level 12. Moreover, in the edge of the oblique side section 11 bottom, the vertical section 14 of the longwise shape of a short rectangle has extended perpendicularly, and the horizontal level 15 of the shape of an oblong rectangle has extended horizontally at it at the soffit section of the vertical section. And the rectangle section 16 of the shape of a square with a bigger length of one side than the width-of-face size of a horizontal level 15 is following the point of a horizontal level 15.
[0047] In case graphical input of such a mask pattern 10 is carried out to a CAD system, let it be the aggregate of two or more figures. Namely, the mask pattern 10 shown in drawing 2 (a) Inclination input figure 11' of the shape of a rectangle which changed into the inclination state as [show / in drawing 2 (b)], Oblong rectangle-like level input figure 12' to which one edge lapped with the edge of this inclination input figure 11' top, Square-like rectangle input figure 13' which lapped with the other-end section of this level input figure 12', Longwise perpendicular input figure 14' to which the upper-limit section lapped with the other-end section of this oblique side input figure 11', this -- perpendicular -- an input -- a figure -- 14 -- ' -- the lower part -- one side -- an edge -- having lapped -- being oblong -- a rectangle -- ** -- level -- an input -- a figure -- 15 -- ' -- this -- level -- an input -- a figure -- 15 -- ' -- an other end -- the section -- having lapped -- a square -- ** -- a rectangle -- an input -- a figure -- 16 -- ' -- ****** -- a CAD system -- inputting -- having . Each input figure 11' - 16' makes it the direction of X horizontally, and makes it the direction of Y perpendicularly, and each side of each input figure 11' - 16' is vectorized and read.
[0048] By this example, for convenience, the vector of each side of input figure 11' - 16' is oriented so that the inside of a figure may turn into right-hand side. Let six input figures 11' read into the CAD system - 16' be the input figure groups S.
[0049] when six input figures 11' - 16' is read, the read input figure group S is one of the figure operations -- an OR operation is carried out (Step 1-3) When an OR operation indicates each side of each input figure 11' - 16' by the vector, it is pattern logical operation from which it detects whether input figure 11' - 16' is the lap of two or more figures, and the number of laps takes out one or more figure portions by judging the inside and the outside of a figure from the sense of a vector.
[0050] When the OR operation of the input figure group S shown in drawing 2 (b) is carried out, as shown in drawing 2 (c), the OR-operation figure F which met the profile of a mask pattern 10 will be obtained. Thus, all the sides of the OR-operation figure F obtained are vectorized so that the interior of a figure may serve as right-hand side. And the number of the OR-operation figures F with which a vector is closed and generated is registered as "N" (Step 1-4). In this example, several N of the OR-operation figure F generated by the OR operation is 1.
[0051] Next, a number n (1-N) is given to every [which was generated by the OR operation] OR-operation figure F, and the middle temporary figure for obtaining an exact LISA IJINGU figure in each OR-operation figure F of every is generated (Step 1-5 - Step 1-23).
[0052] Generation of a temporary figure is carried out as follows. That is, counting of several M of the peak is carried out to each OR-operation figure F of every [which was generated by the OR operation] (Step 1-6 and Step 1-7), and a set of the peak train of a temporary figure is initialized to empty class (Step 1-8).
[0053] Next, it judges whether the oblique side is contained in the OR-operation figure F of a processing object by computing each angle and judging the classification of an angle about all the peaks of each OR-operation figure F made into the object of processing, (Step 1-9).
[0054] The judgment of the classification of the angle of all the peaks of the OR-operation figure F which is a processing object is shown in the flow chart of drawing 3 in detail. That is, first, a CAD system sets the flag D which shows whether the OR-operation figure F contains an oblique side as the initial state of "NO" which does not contain the oblique side (Step 3-1), and the classification of an angle is judged in order to the M peaks in the OR-operation figure F, respectively (Step 3-2 - Step 3-20).
[0055] If all the peaks of the OR-operation figure F are distinguished in order of the registered peak train, for example, the m-th peak is set to V (Step 3-3), in case they will judge the classification of the angle of the peak V, they distinguish first whether LISA IJINGU processing is an expansion operation or it is a reduction operation (Step 3-4). When LISA IJINGU processing is an expansion operation, the interior angle of the peak V is computed as theta (Step 3-5), and, in the case of a reduction operation, the exterior angle of the peak V is computed as theta (Step 3-6). This notes having the property as the exterior angle of the peak V in a reduction operation in which the interior angle of the peak V in an expansion operation is the same based on the fact that the profile of the figure which replaced and carried out reduction data processing of the profile of the figure which carried out expansion data processing to the input figure, and the interior and the exterior of an input figure is the same. Therefore, you may calculate the exterior angle of the peak V in the case of an expansion operation, and the interior angle of the peak V in the case of a reduction operation as theta, respectively.
[0056] Thus, an operation of the interior angle or exterior angle theta of the peak V classifies the peak V into the following six classification T1-T6 based on the value of calculated theta (Step 3-7). Namely, as shown at drawing 4 (a) in the case of expansion data processing, as for the peak V, in the case of 0< theta<pi / 2, the interior angle theta of the peak V is considered as classification T1 (Step 3-8). Like the following, as are shown in drawing 4 (b), and the peak V is shown at classification T2 (Step 3-9) and drawing 4 (c) in the case of theta=pi/2 As the peak V is shown at classification T3 (Step 3-10) and drawing 4 (d) in pi / 2< theta<pi As the peak V is shown at classification T4 (Step 3-11) and drawing 4 (e) in the case of pi<theta <3pi/2 As the peak V is shown at classification T5 (Step 3-12) and drawing 4 (f) in the case of theta=3pi/2, in 3pi/2<theta<2pi, it is carried out to classification T6 (Step 3-13), respectively.
[0057] It changes Flag D into a set state as that by which is followed, and the peak V is included [the interior angle theta of the peak V] for the oblique side in the OR-operation figure F in one case of the classification T1, T3, T4, and T6 pi/2 and not 3pi/2 but when the peaks V are not classification T2 and T5 (Step 3-14 - Step 3-17).
[0058] Thus, the result of an operation of the interior angle (or exterior angle) theta of the obtained peak V and the classification T1-T6 to which the peak V was set are registered, respectively (Step 3-18 and 3-19). And it is registered whether the OR-operation figure F into which the classification of all the peaks was registered contains the oblique side (Step

3-20).
[0059] In addition, it is the case where the classification of all the peaks V in an OR-operation figure is T2 and T5 (when it is theta=pi / 2, and theta=3pi/2), and moreover, when all the sides consist of oblique sides, although the OR-operation figure contains the oblique side, it is judged in fact, to be the figure which does not contain an oblique side. However, even if it processes such an OR-operation figure as a figure which does not contain an oblique side as what is made to rotate the figure constituted by only the perpendicular side and the level side which do not contain an oblique side, and is in the inclination state, there is no especially un-arranging.
[0060] Thus, if the classification of all the peaks in the OR-operation figure F is judged and the existence of an oblique side is set up, as shown in Step 1-10 of drawing 1 , it will judge whether the OR-operation figure F contains the oblique side in the state of the set state of Flag D, and reset. And when the OR-operation figure F does not contain the oblique side and the oblique side is included again by Step 1-11 to 1-14 of drawing 1 , the peak of a temporary figure is generated by Step 1-15 to 1-21 of drawing 1 to each peak of the OR-operation figure F, respectively.
[0061] While setting the m-th peak of a peak train to V as shown in Step 1-12 for example, when the OR-operation figure F does not contain the oblique side, the peak of a temporary figure [as opposed to the peak V for each peak contiguous to this peak V] is generated as U and W based on the process A shown in the flow chart of drawing 5 , respectively (Step 1-13).
[0062] Drawing 6 (a) and (b) are explanatory drawings of the process A carried out in order to generate the peak of the temporary figure to the peak V, when the OR-operation figure F does not contain the oblique side. In Process A, the parallel displacement only of the change width of face d is carried out to the perpendicular direction of each sides UV and VW to the exterior of a figure, respectively in the 2 sides UV and VW which in the case of expansion data processing face across the peak V as shown in drawing 6 (a) (Step 5-2). As shown at drawing 6 (b) in the case of a reduction operation, a parallel displacement is carried out to the interior of a figure.
[0063] The detail in this case is shown in the flow chart of drawing 7 . that is, it faces across the peak V -- the exterior (the case of a reduction operation interior of a figure) of a figure is made to carry out the parallel displacement only of the change width of face (vertical distance) d in the case of an expansion operation, and it makes vector U'V' two sides (vector) of one sides UV of UV and VW (Step 7-1 of drawing 7) this -- a case -- an endpoint -- U -- ' -- the side -- UV -- a parallel displacement -- having carried out -- the time -- a vector -- U'V -- ' -- it can set -- the peak -- U -- corresponding -- an endpoint -- it is -- an endpoint -- V -- ' -- the side -- UV -- a parallel displacement -- having carried out -- the time -- a vector -- U'V -- ' -- it can set -- the peak -- V -- corresponding -- an endpoint -- it is . Since [which faces across the peak V] UV and two side of VW(s) are vectorized, respectively as mentioned above, the direction of the exterior and the direction of the interior of a figure are discriminated easily.
[0064] Next, the parallel displacement only of the change width of face (vertical distance) d is carried out to the exterior (or interior) of a figure, and the side (vector) VW of another side which faced across the peak V in the OR-operation figure F is made into side V" W' (Step 7-2 of drawing 7). Endpoint V" in this case It is an endpoint corresponding to the peak V in vector V'W' at the time of carrying out the parallel displacement of the side VW. Endpoint W' is an endpoint corresponding to the peak W in vector V"W' at the time of carrying out the parallel displacement of the side VW.
[0065] thus -- each -- the side (vector) -- UV -- and -- VW -- a parallel displacement -- carrying out -- having -- if -- a parallel displacement -- the back -- each -- a vector -- U'V -- ' -- and -- V -- " -- W -- ' -- drawing 6 -- (-- b --) -- being shown -- as -- crossing -- a case -- **** -- the -- an intersection -- the peak -- V -- receiving -- temporary -- a figure -- the peak -- V -- " -- ' -- ****** -- registering -- a parallel displacement -- carrying out -- having had -- each -- a vector -- U'V -- ' -- and -- V -- " -- W -- ' -- drawing 6 -- (-- a --) -- being shown -- as -- not crossing -- a case -- **** -- each -- a vector -- U'V -- ' -- and -- V -- " -- W -- ' -- respectively -- having extended -- the time -- an intersection -- the peak -- V -- receiving -- temporary -- a figure -- the peak -- V -- " -- ' -- ******
[0066] The peak of the temporary figure corresponding to all the peaks to the OR-operation figure F is set up one by one by carrying out such processing to the turn of a peak train of having met in the direction of a vector, to all the peaks in the OR-operation figure F. And the peak of the set-up temporary figure is registered in order along the direction of a vector, and let it be the peak train of a temporary figure (Step 5-3).
[0067] On the other hand, when the OR-operation figure F contains the oblique side, it progresses to Step 1-15 of drawing 1 , for example, the m-th peak of a peak train is set to V, and each peak contiguous to this peak V is set to U and W, respectively (Step 1-16). And the attribute of being that in which each peak of the OR-operation figure F receives the influence of an oblique side is judged (Step 1-17).
[0068] The judgment of the attribute of whether the peak V is what is influenced of an oblique side is carried out based on the flow chart shown in drawing 8 . Namely, if the angle theta of the already registered peak V is either of the classification T1 or T3 smaller than pi (Step 8-1) The interior angle theta in the case of an expansion operation A salient (it is smallness from pi), Since the exterior angle theta in the case of a reduction operation is a reentrant angle (it is size from pi), or the peak V The attribute of "P-A" is given to the peak V so that not the thing influenced [especially] of an oblique side but the process A (peak generation process of a temporary figure in case the OR-operation figure F does not contain an oblique side) mentioned above may generate the peak of a temporary figure (Step 8-4).
[0069] On the other hand, the angle theta of the already registered peak V is a larger classification than pi. and when either of the sides of the couple which faces across the peaks U and W, respectively is an oblique side, (Step 8-2 and 8-3), and the peak V as what is influenced of an oblique side The attribute of "P-B" is given to the peak V as what should generate the peak of a temporary figure according to a different process B from the generation method of the peak of the temporary figure by Process A (Step 8-5).
[0070] If this sets to U and W each peak contiguous to the peak V where the interior angle theta turned into a larger reentrant angle than pi as shown in drawing 9 When each sides XU, UV, and WY where the side VW is an oblique side and while facing across the peak V faces across each of other peaks U and W are not oblique sides, respectively, each peaks V and W which constitute the oblique side VW (when it is the level side or the perpendicular side) will be influenced of an oblique side as each endpoint of an oblique side. Moreover, in order that the peak U contiguous to the peak V may share Endpoint V and the side UV of an oblique side VW, it will be influenced of an oblique side. In order that similarly the peak Y contiguous to the peak W may share Endpoint W and the side WY of an oblique side VW, it is influenced of an oblique side VW.

Therefore, the peak which is not influenced of an oblique side VW turns into the peaks X and Z contiguous to the peaks U and Y.
[0071] As opposed to one endpoint V of an oblique side VW thus, the influence of the oblique side In order to reach even a pair each of sides XU, UV, VW, and WY which face across the peaks U and W contiguous to the peak V, respectively When it judges whether an oblique side is in a pair each of sides which face across each peaks U and W contiguous to the peak V which is a processing object and there is an oblique side, an attribute "P-B" is given so that the peak V may generate the peak of a temporary figure according to Process B as what is influenced of an oblique side. Process B is shown in the flow chart of drawing 11 , and is mentioned later.
[0072] "-- P-A -- " -- an attribute -- giving -- having had -- the peak -- V -- expansion -- an operation -- a case -- **** -- drawing 10 -- (-- a --) -- being shown -- as -- the peak -- V -- inserting -- two -- a ** -- the side (vector) -- UV -- and -- VW -- change -- width of face (vertical distance) -- d -- only -- the exterior -- a parallel displacement -- carrying out -- making -- a vector -- U'V -- ' -- and -- V'W -- ' -- In the case of a reduction operation, as shown in drawing 10 (b), it considers as the peak of a temporary figure [as opposed to / only the change width of face (vertical distance) d makes the interior carry out the parallel displacement of two sides of UVs and VW(s), consider as vector U'V' and V"W', and / the peak V for those intersection V"'] which faces across the peak V.
[0073] on the other hand, when the classification of the registered vertical angle V has become either T4 or T6 A reentrant angle (it is size from pi) or the exterior angle theta in the case of a reduction operation is a salient (it is smallness from pi). interior angle / theta / in the case of an expansion operation] Furthermore, it judges by whether either of a pair each of sides which face across each peaks U and W which adjoin [whether the peak V is influenced of an oblique side and] the peak V, respectively is an oblique side (Step 8-2). And when a pair each of sides which face across the peaks U and W, respectively are not oblique sides, respectively, as that in which the peak V does not receive the influence of an oblique side, the attribute of "P-A" is given (Step 8-3), and, as for the peak V, the peak of a temporary figure is generated by Process A.
[0074] The peak V where the attribute of "P-A" was given thus, in the case of an expansion operation As shown in drawing 10 (a), in the case of a reduction operation As shown in drawing 10 (b), the 2 sides UV and VW which face across the peak V only the change width of face (vertical distance) d the exterior -- or -- the interior -- a parallel displacement -- carrying out -- making -- a vector -- U'V -- ' -- and -- V"W -- ' -- ** -- carrying out -- those -- an intersection -- V -- " -- ' -- or -- each -- a vector -- U'V -- ' -- and -- V"W -- ' -- extension wire -- an intersection -- V -- " -- ' -- the peak -- V -- receiving -- temporary -- a figure -- the peak -- ** -- carrying out .
[0075] thus -- an OR operation -- a figure -- F -- the peak -- V -- an attribute -- giving -- having -- if -- drawing 1 -- it can set -- a flow chart -- a step -- one -- - -- 18 -- being shown -- as -- the peak -- V -- an attribute -- judging -- having -- the peak -- V -- an attribute -- "-- P-A -- " -- it is -- a case -- **** -- drawing 5 -- being shown -- a flow chart -- being based -- a process -- A -- the peak --
[0076] On the other hand, when the attribute of the peak V of the OR-operation figure F is "P-B", unlike Process A, the three peaks of the temporary figure to the peak V are generated by Process B as what is influenced of an oblique side (Step 1-20).
[0077] Drawing 11 is explanatory drawing of the generation method of the peak of the temporary figure according [the flow chart and drawing 12 which show how to generate the peak of the temporary figure to the peak V of the OR-operation figure F according to Process B] to the process B. in Process B, in carrying out an expansion operation, as shown in drawing 12 (a), it faces across the peak V -- two sides, only the change width of face (vertical distance) d carries out the parallel displacement of UV and the VW to the exterior of the OR-operation figure F, and makes them vector U'V' and vector V"W', respectively (Step 11-1 of drawing 11) in carrying out a reduction operation, as shown in drawing 12 (b), it faces across the peak V -- two sides, only the change width of face (vertical distance) d carries out the parallel displacement of UV and the VW to the interior of a figure, and makes them vector U'V' and vector V"W', respectively Since all the sides of a figure are vectorized so that the interior of a figure may become right-hand side, the direction of the exterior and the direction of the interior of a figure are easily discriminable.
[0078] Thus, although two endpoints V' and V" are obtained to the peak V, these endpoints V' and V" are registered as the peak of a temporary figure, respectively. In this case, the peak V of the OR-operation figure F is registered as the peak of a temporary figure. temporary -- a figure -- three -- a ** -- the peak -- V -- V -- ' -- V -- " -- as follows -- turn -- registering -- having . That is, since generation of the peak of a temporary figure is carried out in order along the direction of the vector of each vectorized side in an OR-operation figure, while being processed in order of peak U-V-W and processing the peak U in advance of processing of the peak V, the peak W is processed after processing of the peak V. for this reason -- the side -- UV -- a parallel displacement -- having carried out -- the time -- the peak -- V -- corresponding -- an endpoint -- V -- ' -- the peak -- U -- corresponding -- an endpoint -- U -- ' -- the peak -- V -- between -- registering -- having . Endpoint V" corresponding to the peak V at the time of carrying out the parallel displacement of the side VW is registered between endpoint W' and the peaks V corresponding to the peak W. Therefore, as a peak train of a temporary figure, peak V' is registered into the degree of peak U' (Step 11-2), next, the peak V is registered (Step 11-3), and peak V" is registered further after that (Step 11-4). Therefore, as the peak of a temporary figure, it is registered in order of U'-V'-V-V"-W'.
[0079] When the OR-operation figure F obtained when registration of such a peak train of a temporary figure carries out the OR operation of the input figure group S is plurality, the peak train of a temporary figure is generated to each OR-operation figure F so that a temporary figure may be obtained by each OR-operation figure F of every (Step 1-22 of drawing 1 (b)). And a temporary figure is generated by connecting the peak train of all temporary figures to the order by which setting registration was carried out (Step 1-23). When the number of the OR-operation figures F is N, the temporary figure generated also becomes N pieces.
[0080] If all temporary figures are generated, an OR operation will be carried out to a full-temporary figure (Step 1-24). And the figure group which the OR operation was carried out and was obtained is outputted as data S of a LISA IJINGU figure (Step 1-25).
[0081] An OR operation will be carried out by the calculation speed of O (nlogn), if the side sets the total number of the peaks to n to N temporary figures also including intersection.
[0082] If the peak of a temporary figure is registered to all the peaks to the OR-operation figure F shown in drawing 2 (c) based on the flow chart of drawing 1 , one temporary figure 21 shown in drawing 13 (a) will be generated. In this case,

although the number of the peaks of the OR-operation figure F was 18, the number of the peaks of the temporary figure 21 is set to 28. And by carrying out the OR operation of the temporary figure 21 shown in drawing 13 (a), the LISA IJINGU (expansion) figure 22 shown in drawing 13 (b) will be obtained, and this figure will be outputted.
[0083] Although classified into "P-A" which should carry out the process A which generates only the one peak of the temporary figure corresponding to the peak V by judging the attribute of whether the peak V is influenced by the oblique side, and "P-B" which should carry out the process B which generates the three peaks of a corresponding temporary figure according to this example The condition judging of a classification of this attribute can be processed at high speed as compared with the machine time which the OR operation which is only carried out for every peak and is carried out after that takes.
[0084] and the figure which does not contain an oblique side -- receiving -- any of the peak -- although -- since the peak of a temporary figure is classified into the attribute of "P-A" by which only one is generated to the one peak, the total number of the peaks of a temporary figure is cut down, and subsequent OR-operation processing can also be carried out at high speed
[0085] In addition, in the above-mentioned example, when the OR-operation figure F has the oblique side, it sets. When larger than pi, as shown in drawing 8 , the classification of the angle of (peak the judgment of whether T4 - T6), and the judgment V of the attribute of the peak, i.e., the peak, are influenced of an oblique side [the angle theta of the peak V] Although it was made to carry out each peaks U and W contiguous to the peak V by whether either of the sides of the couple inserted, respectively is an oblique side For example, you may make it judge the attribute of the peak V based on the angle (classification T1-T6 of the peaks U and W) of the peaks U and W contiguous to the peak V.
[0086] Drawing 14 shows the flow chart in that case. In this case, in case the attribute of the peak V is investigated, [whether the classification of the peak V is either T1-T3, and] Investigate whether it is either T4-T6 (Step 14-1), and when the classification of the peak V is T1-T3 (angle theta<pi of the peak) The peak V is made into the attribute of "P-A" which should be processed according to Process A like the example shown in drawing 8 as what is not influenced of an oblique side (Step 14-4). That is, if the exterior angle theta of the salient smaller than pi or the peak V in the case of a reduction operation is a bigger reentrant angle than pi, it will consider as the attribute of "P-A" and the one peak of a temporary figure will be generated to the peak V. [interior angle / of the peak V in the case of an expansion operation / theta]
[0087] On the other hand, when the classification of the peak V is T4-T6 (angle theta>pi of the peak V), it investigates, respectively whether the classification of the peaks U and W contiguous to the peak V is T1-T3, or it is T4-T6 (Step 14-2 and 14-3). and any of the peaks U and W contiguous to the peak V -- although -- when it is classification T1-T3 (i.e., only when all have the angle of the peaks U and W smaller than pi), the attribute of "P-B" which should process the peak V according to Process B as what is influenced by the oblique side is given (Step 14-5) When one classification of the peaks U and W contiguous to the peak V is T4-T6, the attribute of "P-A" which should be processed according to Process A is given as that in which, as for the peak V, the angle theta of the peaks U and W does not receive the influence of an oblique side in being larger than pi (Step 14-4).
[0088] In the case of this example, the LISA IJINGU (expansion) temporary figure 23 shown in drawing 15 is generated to the OR-operation figure F shown in drawing 2 (c). In this case, the number of the peaks of the temporary figure 23 is set to 30. And the LISA IJINGU (expansion) figure 22 shown in drawing 13 (b) is obtained by carrying out the OR operation of this temporary figure 23.
[0089] Drawing 16 is a flow chart which shows the example of further others of the method of investigating the attribute of the peak V. In this example, the attribute of whether the peak V is influenced of an oblique side is judged based on the sum of the angle of each peaks U and W contiguous to the angle theta of the peak V, and the peak V, and each angle of each peaks U and W which adjoin the peak V further.
[0090] That is, when the classification of the angle of the peak V is T1-T3 (angle theta<pi of the peak), (Step 16-1) and the peak V are made into the attribute of "P-A" like each aforementioned example as what is not influenced of an oblique side as what is not influenced of an oblique side (Step 16-6).
[0091] on the other hand, any of each peaks U and W which adjoin the peak V when the classification of the angle theta of the peak V is T4 (pi<theta <3pi/2) -- although -- if it is not classification T3 (pi / 2< theta<pi) (Step 16-2 and 16-4), it will consider as the attribute of "P-A" as what is not influenced of the oblique side of the peak V (Step 16-6)
[0092] however, when the classification of the angle theta of the peak V is T4 (pi<theta <3pi/2) and either of each peaks U and W contiguous to the peak V is classification T3 (pi / 2< theta<pi) Only when the sum of the angle of the peaks U or W of classification T3 and the angle of the peak V is larger than 2pi, the peak V is made into the attribute of "P-B" as what is influenced of an oblique side (Step 16-7). When the classification of the angle of the peak V is T4, the attribute of the peak V is made into "P-A" except such a condition.
[0093] Thereby, when carrying out the expansion operation of the OR-operation figure, the interior angle theta of the peak V is a reentrant angle of pi<theta <3pi/2, and moreover one interior angle theta' of the adjoining peaks U or W is the salient of pi/2<theta'<pi, it restricts to the time when it is >(theta+theta') 2pi further, and "P-B" is given as an attribute of the peak V. Therefore, when only the oblique side (45 degrees or 135 degrees) is contained in the OR-operation figure, the combination of the peak V and the peaks U or W with which are satisfied of this condition does not exist, but in this case, the attribute of P-A is given and, as for each peak of an OR-operation figure, every one peak of a temporary figure is generated to each peak.
[0094] If either of each peaks U and W contiguous to the peak V is classification T3 (pi / 2< theta<pi) as shown in drawing 16 (b) when the classification of the angle of the peak V is T5 (theta=3pi/2) (Step 16-8 and 16-9), the attribute of the peak V will be made into "P-B" (Step 16-7). In the case where the classification of the angle of the peak V is T5 (theta=3pi/2), if there is nothing on such conditions, the attribute of the peak V will be made into "P-A" (Step 16-6).
[0095] Thereby, when carrying out the expansion operation of the OR-operation figure, the interior angle theta of the peak V is a reentrant angle of theta=3pi/2, one interior angle theta' of the adjoining peaks U or W restricts to the time when it is the salient of pi/2<theta'<pi, and the peak V is made into the attribute of "P-B" as what is influenced of an oblique side. Therefore, when only the oblique side (45 degrees or 135 degrees) is contained in the OR-operation figure, the angle theta of the peak V is 270 degrees, and only when angle theta' of the peaks U or W is 135 degrees, the three peaks of a temporary figure are generated by Process B as that in which the peak V receives the influence of an oblique side.

[0096] If either of each peaks U and W contiguous to the peak V is classification T2 (theta=pi/2) or T3 (pi / 2< theta<pi) as shown in drawing 16 (c) when the classification of the angle of the peak V is T6 (3pi/2<theta<2pi) (Step 16-10 and 16-12), the attribute of the peak V will be made into "P-B" (Step 16-7). Moreover, if either of each peaks U and W contiguous to the peak V is classification T1 (0< theta<pi / 2) and the sum of the angle of the peaks U or W of classification T1 and the angle of the peak V is larger than 2pi (Step 16-11 and 16-13), the attribute of the peak V will be made into "P-B" (Step 16-7). In the case (3pi/2<theta<2pi) where the classification of the angle of the peak V is T6, if it has not been such conditions, the peak V will be made into the attribute of "P-A" as what is not influenced of an oblique side (Step 16-6).
[0097] By this, in carrying out the expansion operation of the OR-operation figure the interior angle theta of the peak V -- 3pi/2 < -- one interior angle theta' of the peaks U or W which are the reentrant angles of theta<2pi and moreover adjoin -- pi/2<=theta' -- or [that it is the salient of <pi] -- or It restricts to the time when it is >(theta+theta') 2pi in the salient of 02<theta'<pi/2, and the attribute of "P-B" is given as that in which the peak V receives the influence of an oblique side. Therefore, when only the oblique side (45 degrees or 135 degrees) is contained in the OR-operation figure, the peak of three temporary figures is generated by Process B as what is influenced of an oblique side only at the time of angle theta'=135 degree of the time of angle theta'=90 degree of the angle of theta= 315 degrees of the peak V, and the peaks U or W or the angle of theta= 315 degrees of the peak V, and the peaks U or W.
[0098] Although the attribute of the peak V is classified into "P-A" which should carry out the process A which generates only the one peak of a corresponding temporary figure, and "P-B" which should carry out the process B which generates the three peaks of a corresponding temporary figure according to this example, the condition judging of a classification of this attribute can be processed at high speed as compared with the machine time which the OR operation which is only carried out for every peak and is carried out after that takes.
[0099] and -- the case of the figure which does not contain an oblique side -- any of the peak -- although -- the peak of a temporary figure is classified into the attribute of "P-A" by which only one is generated to the one peak Moreover, the figure which contains only an oblique side (45 degrees and 135 degrees) to the level side in addition to the perpendicular side and the level side is also received. The angle (the case of an expansion operation the case of the angle of an interior angle, and a reduction operation angle of an exterior angle) theta of the two continuous peaks, and the combination of theta' theta= 270 degrees and theta'=135 degree, and theta= 315 degrees and theta'=90 degree, In the case of three kinds (theta= 315 degrees and theta'=135 degree), it is restricted, only the peak used as the angle theta is classified into "P-B" so that three may be generated as the peak of a temporary figure, and other peaks are classified into "P-A."
[0100] Therefore, in this example, the number of the peaks of a bird clapper of a temporary figure is very rare for the attribute "P-B" to which the process B by which the peak of three temporary figures is generated to the peak of an OR-operation figure is applied. Consequently, the number of the peaks of a temporary figure can be cut down remarkably, and it becomes possible to shorten remarkably the time which OR-operation processing of a temporary figure takes.
[0101] In the case of this example, the LISA IJINGU (expansion) temporary figure 24 shown in drawing 17 is generated to the OR-operation figure F shown in drawing 2 (c). In this case, to the total 18 peaks of the input figure F, the number of the peaks of the temporary figure 24 is set to 22, and the four peaks are increasing it. And the LISA IJINGU (expansion) figure 22 shown in drawing 13 (b) is obtained by carrying out the OR operation of this temporary figure 24.
[0102] Therefore, in a complicated figure like a circuit pattern with bending [much], when the oblique side is used locally, by this example, the scope of the process B which generates the peak of three temporary figures can be limited, and high-speed processing is attained.
[0103]
[Effect of the Invention] The LISA IJINGU method of the mask pattern of this invention judges whether the oblique side is contained to the input figure in this way, and only when it judges whether each peak of an input figure is influenced of an oblique side when the oblique side is contained and the peak is influenced of an oblique side, it is made to generate the peak of three temporary figures to the peak further. Therefore, even if the oblique side is contained in the input figure, to the peak which is not influenced of an oblique side, only one can be generated, but the peak of a temporary figure can cut down the total number of the peaks of a temporary figure, and can accelerate subsequent OR-operation processing.
[0104] Although it can judge by a pair each of sides which face across each peak contiguous to the peak, respectively, whether the peak is influenced of an oblique side By judging further based on the sum with the angle of the peak of the angle of each peak contiguous to the angle and the peak of the peak, and either of the adjoining peaks based on the angle of each peak contiguous to the angle and the peak of the peak The range to which the process which generates the peak of three temporary figures is applied is restricted, further, it is cut down and the total number of the peaks of a temporary figure can accelerate subsequent OR-operation processing.

[Translation done.]

* NOTICES *

1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

TECHNICAL FIELD

[Industrial Application] this invention relates the mask pattern carried out using a CAD (Computer Aided Design) system to expansion data processing and the LISA IJINGU method which carries out reduction data processing.

[Translation done.]

PRIOR ART

[Description of the Prior Art] LSI is designed by the CAD system with large-scale high integration of LSI now. Especially, the figure calculation function must not be in the artwork system for a mask pattern.

[0003] As one of the figure operations, LISA IJINGU (resizing) which performs expansion and reduction of a mask pattern is used for the design rule verification about the minimum spacing and the minimum width of face of a mask pattern, extraction of the field which can be wired, a notch, removal of a salient, etc. LISA IJINGU in this case is operation which only the change width of face specified the exterior or inside the figure carries out the parallel displacement of each of that side by making a mask pattern into an input figure, and obtains an enlarged-view form or a reduction figure, and is not operation of obtaining a similar figure.

[0004] For example, operation of only the specification width of face d making the parallel displacement of each side of the input figure 30 carrying out outside, respectively as shown in drawing 18 (b) by making a mask pattern as shown in drawing 18 (a) into the input figure 30, and obtaining enlarged-view form 31 is LISA IJINGU (expansion operation), and as shown in drawing 18 (c), it differs from operation of making each side of the input figure 30 expanding, respectively, and obtaining a similar figure 32.

[0005] By the expansion operation (expanding) in LISA IJINGU As are shown in drawing 19 (a), and the external field 33 in the range of the specification width of face d also makes it the fundamental concept to treat as the interior of a figure from each side of the input figure 30 and a reduction operation (shrinking) shows to drawing 19 (b) It is making into the fundamental concept to also treat the internal field 34 which is in the range of the specification width of face d from each side of an input figure as the exterior of a figure. If the interior angle of the peak in the input figure 30 is a salient (it is smallness from pi) in the case of the expansion operation, the peak will become radii-like by expanding only the specification width of face d.

[0006] For example, as shown at drawing 19 (c) in the case of an expansion operation, although peak 30a from which the interior angle in the input figure 30 turned into a salient disappears when each sides 30b and 30c which constitute the peak carry out a parallel displacement, respectively, when the sector interpolation figure 35 interpolates, it becomes radii-like. However, in the mask pattern, difficult, from the bird clapper, handling adds the additional figure 36 surrounded by each tangent and radii portion of ends of a radii portion in the sector interpolation figure 35 to the sector interpolation figure 35, and if the circular sector interpolation figure 35 exists, as shown in drawing 19 (d), as shown in drawing 19 (e), it is changing the sector interpolation figure 35 into the square interpolation figure 37. Thereby, enlarged-view form (LISA IJINGU figure) 31 shown in drawing 19 (f) are obtained.

[0007] The reduction figure (LISA IJINGU figure) 38 shown in drawing 19 (g) is obtained by treating the square interpolation figure from which the additional figure surrounded by each tangent and radii portion of ends of a radii portion in a sector interpolation figure was similarly added to the sector interpolation figure in the reduction operation and which it consisted of as the exterior of a figure.

[0008] Thus, the obtained LISA IJINGU figure is used for the rule verification about the minimum spacing and the minimum width of face of a mask pattern of IC, extraction of the field which can be wired, a notch, removal of a salient, etc.

[0009] While design rule verification of minimum spacing judges whether it is mutually separated only from the minimum spacing d two or more mask patterns were specified to be, when minimum spacing d is not being filled, it is processing which specifies the portion. for example, as shown in drawing 20 (a), when the input figures 41 and 42 equivalent to the mask pattern of the couple which became parallel to mutual verify whether minimum spacing d is satisfied As are shown in drawing 20 (b), and an expansion operation is carried out by one half of the width of face of minimum spacing d and each input figures 41 and 42 are shown in drawing 20 (c) When the LISA IJINGU figures 43 and 44 by which the expansion operation was carried out have lapped mutually, each input figures 41 and 42 are specified in the lap portion 45 as what has not satisfied minimum spacing d.

[0010] The minimum width-of-face verification for example, the figure 46 equivalent to the mask pattern of a configuration as shown in drawing 21 (a) As it is the processing which verifies whether the minimum width-of-face size is satisfied, the reduction operation of the input figure 46 equivalent to a mask pattern is carried out by one half of the width of face of the minimum width-of-face size d and it is shown in drawing 21 (b) If the LISA IJINGU figure 47 by which the reduction operation was carried out is divided into two or more figures 47a and 47b, as shown in drawing 21 (c), the separated portion 48 specifies as what has not satisfied the minimum width-of-face size d.

[0011] Extraction of the field which can be wired like [as shown in drawing 22 (a)] the field already wired As shown in drawing 22 (b), three input figures 51, 52, and 53 which show the field whose wiring is impossible As only the size d equal to the sum of the one half and wiring minimum spacing of wiring width of face carries out an expansion operation, respectively and is shown in drawing 22 (c), each LISA IJINGU figures 54 and 55 by which the expansion operation was carried out, and fields 57 other than 56 are extracted as a field which can be wired.

[0012] The width-of-face size of a notch [in / a mask pattern / with removal of a notch or a salient] (interval of a notching portion), Or when the width of face of a salient has not satisfied the minimum size, as a part for the notch portion or a height is removed and it is shown in drawing 23 (a) In the case of the input figure 61 which has notch 61a, with one half of the sizes

of the minimum width-of-face size d of notch 61a, the expansion operation of the figure 61 is carried out, and as shown in drawing 23 (b), the LISA IJIGU figure 62 by which the expansion operation was carried out is obtained. Then, as shown in drawing 23 (c), only the same size (d/2) carries out the reduction operation of the LISA IJINGU figure 62 by which the expansion operation was carried out. When the width-of-face size of notch 61a has not satisfied the minimum width-of-face size d, notch 61a will be removed by the LISA IJINGU figure 63 obtained according to a reduction operation.

[0013] With increase of the number of figures by the large-scale integration of IC, help processing becomes difficult and the figure operation which processes the figure group which constitutes the mask pattern of IC is processed by the CAD system. For example, the method of creating automatically the overlap between the contiguity patterns to which the computer was applied is indicated by JP,3-9474,A, and the method of creating the mask data for semiconductor manufacture using CAD data is indicated by JP,6-19110,A.

[0014] Moreover, the various proposals of the high-speed algorithm are made from the need of processing a huge number of figures at the figure operation.

[0015] For example, the OR operation which is one of the figure operations is reported to "A Concurrent pattern Operation Algorithm for VLSI Mask Data (Proc.18 th Design Automation Conference, 1981)" (let this report be a conventional method 1 hereafter). An OR operation is an operation which extracts the boundary line which separates the field with which one or more figures have lapped, and the field where one does not have a figure, and by this report, if the total number of the peaks of the input figure group before OR-operation execution is set to n, it can obtain the figure group after an OR operation by the calculation complexity of O (n log n).

[0016] An example of an OR operation is shown in drawing 24 . As shown in drawing 24 (a), in carrying out the OR operation of the square small input figure 65, the square big input figure 66, the input figure 67 of the rectangle to which the part lapped with the input figure 66 of this big square, and the input figure 68 that shows opening of a still smaller rectangle, it vectorizes all the sides of each input figures 65-68. In this example, each side is vectorized so that the interior of a figure may become right-hand side for convenience, therefore each side of the input figure 68 of opening is vectorized so that the interior of opening may become left-hand side. And the number of laps of the input figures 65-68 is obtained from the sense of a vector, and one or more portions are taken out for the number of laps. Usually, the number of laps of one input figure which is not opening is 1, and the outside of a figure is 0. Moreover, in the portion with which two input figures have lapped, the number of laps is 2 and, as for opening, the number of laps is set to -1. As a result of an OR operation, the figure shown in drawing 24 (b) is obtained, and the input figure 68 of opening which became negative disappears.

[0017] Moreover, expansion and the reduction operation of a figure are reported to "An O(n log n) algorithm forLSI layout resizing problems (85 ISCAS '1985)" (let this report be a conventional method 2 hereafter). In this report, a LISA IJINGU figure is obtained by performing separately expansion of the direction of X, expansion of reduction and the direction of Y, or reduction.

[0018] For this reason, theoretically, when the total number of the peaks of an input figure group is set to n, although it can process in the calculation complexity of O (n log n), since expansion with the direction of X and the direction of Y or reduction is carried out separately, there is a problem that improvement in the speed of the processing time is difficult.

[0019] And since it is aimed at the figure which consists only of the level side and the perpendicular side parallel to the direction of X, and the direction of Y fundamentally, although the input figure which has angle (45 degrees or 135 degrees) of an oblique side to the X-axis is also possible for LISA IJINGU processing, processing of an oblique side becomes complicated. For example, as shown in drawing 25 (a), neither the input figure 70 which has the short level side 73 among the oblique sides 71 and 72 of a couple, nor a LISA IJINGU figure exact as shown in drawing 25 (b) rather than the length of the level side 73 and the perpendicular side 76, when carrying out the expansion operation of the input figure 77 which has the short perpendicular side 76 between an oblique side 74 and the level side 75 by major-change width of face is obtained. The exact expansion data-processing figure of each figure will be disappeared by the level side 73 and the side corresponding to the perpendicular side 76, respectively, as an alternate long and short dash line shows to drawing 25 (a) and (b). In order to obtain such an exact expansion data-processing figure, intersection calculation of intersection calculation of the oblique sides 71 and 72 of the couple which faces across the level side 73, the oblique side 74 which faces across the perpendicular side 76, and the perpendicular side 75 is needed for expansion processing of the direction of X of each side, and the direction of Y further, respectively. Therefore, it is not easy to be unable to obtain an exact LISA IJINGU figure, if such complicated processing is not added, but to accelerate the processing time.

[0020] Furthermore, in order to obtain a LISA IJINGU figure for the input figure which becomes "the enlarging-or-contracting technique (Information Processing Society of Japan research report DA 43-4 and 1988-7) of an LSI pattern including the arbitrary angle side" from the arbitrary angle side, the method of obtaining a LISA IJINGU figure is indicated by generating a middle temporary figure and carrying out the OR operation of the generated temporary figure (let this be a conventional method 3 hereafter).

[0021] The flow chart of this conventional method 3 is shown in drawing 26 . In this conventional method 3, first, if the change width of face d is read (step 26- of drawing 26 (a) it is the same as that of 1 and the following), the input figure group S which consists of two or more input figures will be read (Step 26-2). And the OR operation of the read input figure group S is carried out (Step 26-3).

[0022] When a mask pattern is inputted as a figure group constituted by two or more figures, expansion data processing or before carrying out reduction data processing, an OR operation is needed in a mask pattern. For example, if expansion data processing of it is carried out without carrying out OR-operation processing when the mask pattern 80 shown in drawing 27 (a) is inputted as input figures 81, 82, and 83 of three rectangles, as shown in drawing 27 (b), as shown in drawing 27 (c) all -- an input -- a figure -- 81 -- 82 -- 83 -- expansion -- data processing -- carrying out -- having -- a sake -- each -- an input -- a figure -- 81 -- 82 -- 83 -- receiving -- an enlarged view -- type -- 81 -- ' -- 82 -- ' -- 83 -- ' -- obtaining -- having -- these -- an enlarged view -- type -- 81 -- ' -- 82 -- ' -- 83 -- ' -- an OR operation -- processing -- carrying out -- even if -- being exact -- LISA -- IJINGU -- a figure -- For this reason, when a mask pattern is inputted by the figure group which consisted of two or more figures, an OR operation is needed to the input figure group.

[0023] Then, a temporary figure is generated to all the N input figures, using the number of figures after OR-operation processing of an input figure group as N (Step 26-4) (Step 26-5 to 26-18).

[0024] On the occasion of generation of a temporary figure, the number of the peaks of the input figure F is set to M, using the n-th input figure as F (Step 26-6) (Step 26-7), all the peaks are oriented as a peak train, and each side is vectorized (Step 26-8). And the peak of a temporary figure is generated to all the peaks (Step 26-9 to 26-16).
[0025] The peak of a temporary figure sets to W the peak which adjoins the peak which adjoins an opposite side with the direction of the vector of V and its peak V in the m-th peak of the peak train in the input figure F in U and the direction of a vector of the peak V (Step 26-10), and LISA IJINGU judges an expansion operation or a reduction operation (Step 26-11). And when LISA IJINGU is an expansion operation, the interior angle of the peak V judges a salient (it is smallness from pi), and a reentrant angle (it is size from pi) (Step 26-12). When the interior angle of the peak V is a salient, let the intersection of each vectors acquired in the sides UV and VW of the couple which faces across the peak V by carrying out the parallel displacement only of the change width of face d to the exterior of an OR-operation figure, respectively, or those extension wire be the peak of a temporary figure (Step 26-14). The generation method of the peak of such a temporary figure is made into Process A.
[0026] moreover, when LISA IJINGU is an expansion operation and the interior angle of the peak V is a reentrant angle the peak -- V -- inserting -- a couple -- the side -- UV -- and -- VW -- respectively -- change -- width of face -- d -- only -- an OR operation -- a figure -- the exterior -- a parallel displacement -- carrying out -- obtaining -- having -- each -- a vector -- U'V -- ' -- and -- V"W -- ' -- the peak -- V -- corresponding -- each -- an endpoint -- V -- ' -- and -- V -- " -- The peak V of an input figure is registered as the peak of a temporary figure in order of V', V, and V", respectively (Step 26-15). The generation method of the peak of such a temporary figure is made into Process B.
[0027] When LISA IJINGU is a reduction operation, the interior angle of the peak V judges a salient (it is smallness from pi), and a reentrant angle (it is size from pi) (Step 26-13), and when the interior angle of the peak V is a reentrant angle, contrary to the case of an expansion operation according to Process A Let the intersection of the vectors acquired in the sides UV and VW of the couple which faces across the peak V by carrying out the parallel displacement only of the change width of face d to the interior of an OR-operation figure, respectively, or those extension wire be the peak of a temporary figure (Step 26-14). When LISA IJINGU is a reduction operation and the interior angle of the peak V is a salient a process -- B -- the peak -- V -- inserting -- a couple -- the side -- UV -- and -- VW -- respectively -- change -- width of face -- d -- only -- an OR operation -- a figure -- the interior -- a parallel displacement -- carrying out -- obtaining -- having -- each -- a vector -- U'V -- ' -- and -- V"W -- ' -- the peak -- V -- corresponding -- an endpoint -- V -- ' -- and -- V -- " -- The peak V of an OR-operation figure is registered as the peak of a temporary figure in order of V', V, and V", respectively (Step 26-15).
[0028] A temporary figure is generated by carrying out generation of such the peak of a temporary figure to all the figures produced by the OR operation (Step 26-17), and connecting in order the peak where the temporary figure was registered (Step 26-18). And the OR operation of the generated temporary figure is carried out (Step 26-19), and the figure by which the OR operation was carried out is outputted as a LISA IJINGU figure S (Step 26-20). Although the temporary figure will be crossed by the side, it is made an exact LISA IJINGU figure by the OR operation.
[0029] In this conventional method 3, as shown in drawing 28 (a), when the number of the peaks is the input figure 84 of 18, as shown in drawing 28 (b), let the number of the peaks be the temporary figure 85 of 32, for example.
[0030] In such an operation art, by processing of the any 1 direction of the direction of X, or the direction of Y, even if the oblique side is included, an exact LISA IJINGU figure without an error can be obtained. Moreover, each peak of an OR-operation figure is processed in order along the side, and in order to end by going around an OR-operation figure, it can process easily by the trouble of O (n). Furthermore, the calculation complexity of O (n log n) is realizable like the case of the OR operation of a conventional method 2 by adopting a conventional method 1 as the OR operation carried out for neighboring intersection processing. And since internal data structure becomes a linear list, it becomes possible to process rather than the case where the in-house data is not a linear list, like a conventional method 2 at high speed.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] The LISA IJINGU method of the mask pattern of this invention judges whether the oblique side is contained to the input figure in this way, and only when it judges whether each peak of an input figure is influenced of an oblique side when the oblique side is contained and the peak is influenced of an oblique side, it is made to generate the peak of three temporary figures to the peak further. Therefore, even if the oblique side is contained in the input figure, to the peak which is not influenced of an oblique side, only one can be generated, but the peak of a temporary figure can cut down the total number of the peaks of a temporary figure, and can accelerate subsequent OR-operation processing.
[0104] Whether the peak is influenced of an oblique side is a pair each of sides which face across each peak contiguous to the peak, respectively. Although it can judge By judging further based on the sum with the angle of the peak of the angle of each peak contiguous to the angle and the peak of the peak, and either of the adjoining peaks based on the angle of each peak contiguous to the angle and the peak of the peak The range to which the process which generates the peak of three temporary figures is applied is restricted, further, it is cut down and the total number of the peaks of a temporary figure can accelerate subsequent OR-operation processing.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] In a conventional method 3, since a temporary figure is generated by the calculation complexity of O (n log n), the time which the OR operation of a temporary figure takes the machine time of the whole processing is almost the case. However, in order to consider as the process B which the peak of an input figure judges a salient or a reentrant angle, and considers as the process A which generates only the one peak of a temporary figure on the occasion of generation of the peak of a temporary figure, or generates the three peaks When the peak of an input figure is a reentrant angle (or salient) at the time of an expansion operation (or reduction operation), three will be generated as the peak of the temporary figure corresponding to the peak. Consequently, the number of the peaks of a temporary figure increases and there is a problem that the OR operation of a temporary figure takes a long time.

[0032] As a method of cutting down the total number of the peaks of a temporary figure, generating the peak of one temporary figure to each peak of an input figure is also considered by applying the process A of a conventional method 3 for generation of the peak of a temporary figure. Hereafter, this is made into a conventional method 4 and the flow chart is shown in drawing 29 . In the flow chart of drawing 29 , the above-mentioned process A generates all the peaks of a temporary figure (Step 29-11), and other steps are the same as that of the flow chart of a conventional method 3 shown in drawing 26 .

[0033] Only the specification width of face d carries out the parallel displacement of the two sides which face across the peak, and the generation method of each peak of the temporary figure in this conventional method 4 makes the intersection of each side by which the parallel displacement was carried out, or the intersection of the extension wire of each side by which the parallel displacement was carried out the peak of a temporary figure. Therefore, the one peak of a temporary figure is generated to the one peak of an input figure. And a temporary figure is generated by connecting the peak of a temporary figure in order. Therefore, the oblique side is contained in the input figure, moreover, when there are many peaks of an input figure which became a reentrant angle (at or the time of a reduction operation salient) at the time of an expansion operation, the total number of the peaks of a temporary figure can be lessened compared with a conventional method 3, and the time which an OR operation takes is also shortened.

[0034] However, as shown in drawing 30 (a), when the input figure 86 which consists of two or more squares has an oblique side, the expansion operation figure 87 shown with an alternate long and short dash line is obtained, and since partial 87a which should be treated as the interior of a figure is originally recognized as the exterior of a figure, the mistaken temporary figure is generated. Also in the case of the input figure 88 which similarly has an oblique side as shown in drawing 30 (b), the mistaken temporary figure partial 89a by which the expansion operation figure 89 should be treated as the interior of a figure has been recognized to be as the exterior of a figure is generated.

[0035] this invention solves such a problem, and the purpose is in offering the LISA IJINGU method of the mask pattern which can obtain an exact LISA IJINGU figure at high speed, when the figure which constitutes the mask pattern of IC contains the oblique side.

[Translation done.]

MEANS

[Means for Solving the Problem] The LISA IJINGU method of the mask pattern of this invention By the CAD system, each side of the input figure corresponding to a mask pattern The process which is the LISA IJINGU method of the mask pattern which the exterior or the interior of the input figure is made to carry out a parallel displacement, and obtains an enlarged-view form or a reduction figure, and judges whether the aforementioned input figure contains an oblique side, The process which judges whether the peak is influenced of an oblique side for every peak of the input figure when the input figure contains the oblique side, The process which makes each endpoint corresponding to the peak at the time of carrying out the parallel displacement of the side of the couple of the input figure which faces across the peak to the interior or the exterior of a figure when the peak of an input figure is influenced of an oblique side the peak of a temporary figure with the peak, When the peak of an input figure is not influenced of an oblique side The process which carries out the parallel displacement of the side of the couple of the input figure which faces across the peak to the exterior or the interior of a figure, respectively, and makes the intersection of each side by which the parallel displacement was carried out, or the intersection of the extension wire of each side by which the parallel displacement was carried out the peak of the temporary figure to the peak of an input figure, It is characterized by including the process which connects each peak of the obtained temporary figure and generates a temporary figure, and the process which carries out the OR operation of the generated temporary figure, and the above-mentioned purpose is attained by that.
[0037] In addition, it is desirable to judge based on the sum of the angle of the peak, the angle of each peak contiguous to the peak, and the angle of each of each peak which adjoins the angle of the peak based on the angle of each peak contiguous to whether the oblique side is contained in the side of the couple which faces across each peak where each peak of an input figure adjoins [whether it is influenced of an oblique side and] the peak, and its peak.

[Translation done.]

OPERATION

[Function] By the LISA IJINGU method of the mask pattern of this invention, first, each side of the input figure equivalent to a mask pattern, when it judges whether the oblique side is contained and the oblique side is contained, each peak of an input figure judges whether the influence of an oblique side is received. And in the case of the peak which is not influenced of an oblique side, in the case of an expansion operation, in the case of the exterior of a figure, and a reduction operation, the parallel displacement of the side of the couple which faces across the peak is carried out to the interior of a figure, respectively, and let the intersection of each side by which the parallel displacement was carried out, or the intersection of the extension wire of each side be the peak of a temporary figure. Therefore, in this case, the one peak of a temporary figure is generated to the one peak. When the peak is influenced of an oblique side, in the case of an expansion operation, in the case of the exterior of a figure, and a reduction operation, the parallel displacement of the side of the couple which faces across the peak is carried out to the interior of a figure, respectively, and three of each of each endpoint corresponding to the peak and the peaks of the input figure of a basis in each side by which the parallel displacement was carried out are set up as the peak of a temporary figure.
[0039] A setup of the peak of a temporary figure obtains a LISA IJINGU figure by connecting each peak, and generating and carrying out the OR operation of the temporary figure.
[0040] In the mask pattern of IC, if either of the sides of a couple is an oblique side, respectively, although each peak in an input figure will be made into the thing which is faced across each peak contiguous to the peak and which is influenced of an oblique side, since an oblique side is used for a part of figure, it is rare that the process which generates the peak of three temporary figures is adopted, and the total number of the peaks of a temporary figure can usually, be cut down. The time which a subsequent OR operation takes can be shortened and the rapidity of processing is raised.
[0041] Moreover, by judging whether the peak of an input figure is influenced of an oblique side based on the angle of each peak contiguous to the peak, that the process which generates the peak of three temporary figures is adopted decreases, and the rapidity of graphics processing is raised. Furthermore, by judging whether the peak of an input figure is influenced of an oblique side based on the sum of the angle of the peak, the angle of each peak contiguous to the peak, and the angle of each of each peak which adjoins the angle of the peak, the scope of the process which generates the peak of three temporary figures is limited further, and graphics processing is accelerated further.

[Translation done.]

* NOTICES *

EXAMPLE

[Example] Hereafter, the example of this invention is explained in detail based on a drawing.
[0043] The LISA IJINGU method of the mask pattern of this invention is CAD (Computer Aided Design) because of verification of the mask pattern of LSI etc. When only the change width of face specified the exterior or inside the figure carries out the parallel displacement of each side of the input figure by making a mask pattern into an input figure by the system, it is the method of obtaining an enlarged-view form or a reduction figure.
[0044] Drawing 1 is a flow chart which shows an example of the LISA IJINGU method of the mask pattern of this invention. in this example, first, as shown in drawing 1 (a), the mask pattern inputted into a CAD system is inputted into expansion data processing or the change width of face d of each side at the time of carrying out reduction data processing (LISA IJINGU processing) (one to step 1 reference of drawing 1 , and the following -- the same) In this case, positive and change width of face when reducing are made negative for the change width of face when expanding an input figure.
[0045] Next, the data of the mask pattern of LSI set as the object of LISA IJINGU is inputted with X-Y coordinate (Step 1-2).
[0046] Drawing 2 (a) shows an example of the mask pattern inputted. This mask pattern 10 has the oblique side section 11 which inclines at 45 degrees in the center section, and the horizontal level 12 of the shape of an oblong rectangle has extended horizontally from the edge of the oblique side section 11 top. The rectangle section 13 of the shape of a square with a bigger length of one side than the width-of-face size of a horizontal level 12 is following the point of this horizontal level 12. Moreover, in the edge of the oblique side section 11 bottom, the vertical section 14 of the longwise shape of a short rectangle has extended perpendicularly, and the horizontal level 15 of the shape of an oblong rectangle has extended horizontally at it at the soffit section of the vertical section. And the rectangle section 16 of the shape of a square with a bigger length of one side than the width-of-face size of a horizontal level 15 is following the point of a horizontal level 15.
[0047] In case graphical input of such a mask pattern 10 is carried out to a CAD system, let it be the aggregate of two or more figures. Namely, the mask pattern 10 shown in drawing 2 (a) Inclination input figure 11' of the shape of a rectangle which changed into the inclination state as [show / in drawing 2 (b)], Oblong rectangle-like level input figure 12' to which one edge lapped with the edge of this inclination input figure 11' top, Square-like rectangle input figure 13' which lapped with the other-end section of this level input figure 12', Longwise perpendicular input figure 14' to which the upper-limit section lapped with the other-end section of this oblique side input figure 11', this -- perpendicular -- an input -- a figure -- 14 -- ' -- the lower part -- one side -- an edge -- having lapped -- being oblong -- a rectangle -- ** -- level -- an input -- a figure -- 15 -- ' -- this -- level -- an input -- a figure -- 15 -- ' -- an other end -- the section -- having lapped -- a square -- ** -- a rectangle -- an input -- a figure -- 16 -- ' -- ****** -- a CAD system -- inputting -- having . Each input figure 11' - 16' makes it the direction of X horizontally, and makes it the direction of Y perpendicularly, and each side of each input figure 11' - 16' is vectorized and read.
[0048] By this example, for convenience, the vector of each side of input figure 11' - 16' is oriented so that the inside of a figure may turn into right-hand side. Let six input figures 11' read into the CAD system - 16' be the input figure groups S.
[0049] when six input figures 11' - 16' is read, the read input figure group S is one of the figure operations -- an OR operation is carried out (Step 1-3) When an OR operation indicates each side of each input figure 11' - 16' by the vector, it is pattern logical operation from which it detects whether input figure 11' - 16' is the lap of two or more figures, and the number of laps takes out one or more figure portions by judging the inside and the outside of a figure from the sense of a vector.
[0050] When the OR operation of the input figure group S shown in drawing 2 (b) is carried out, as shown in drawing 2 (c), the OR-operation figure F which met the profile of a mask pattern 10 will be obtained. Thus, all the sides of the OR-operation figure F obtained are vectorized so that the interior of a figure may serve as right-hand side. And the number of the OR-operation figures F with which a vector is closed and generated is registered as "N" (Step 1-4). In this example, several N of the OR-operation figure F generated by the OR operation is 1.
[0051] Next, a number n (1-N) is given to every [which was generated by the OR operation] OR-operation figure F, and the middle temporary figure for obtaining an exact LISA IJINGU figure in each OR-operation figure F of every is generated (Step 1-5 - Step 1-23).
[0052] Generation of a temporary figure is carried out as follows. That is, counting of several M of the peak is carried out to each OR-operation figure F of every [which was generated by the OR operation] (Step 1-6 and Step 1-7), and a set of the peak train of a temporary figure is initialized to empty class (Step 1-8).
[0053] Next, it judges whether the oblique side is contained in the OR-operation figure F of a processing object by computing each angle and judging the classification of an angle about all the peaks of each OR-operation figure F made into the object of processing, (Step 1-9).
[0054] The judgment of the classification of the angle of all the peaks of the OR-operation figure F which is a processing object is shown in the flow chart of drawing 3 in detail. That is, first, a CAD system sets the flag D which shows whether the OR-operation figure F contains an oblique side as the initial state of "NO" which does not contain the oblique side (Step 3-1), and the classification of an angle is judged in order to the M peaks in the OR-operation figure F, respectively (Step 3-2 - Step 3-20).

[0055] If all the peaks of the OR-operation figure F are distinguished in order of the registered peak train, for example, the m-th peak is set to V (Step 3-3), in case they will judge the classification of the angle of the peak V, they distinguish first whether LISA IJINGU processing is an expansion operation or it is a reduction operation (Step 3-4). When LISA IJINGU processing is an expansion operation, the interior angle of the peak V is computed as theta (Step 3-5), and, in the case of a reduction operation, the exterior angle of the peak V is computed as theta (Step 3-6). This notes having the property as the exterior angle of the peak V in a reduction operation in which the interior angle of the peak V in an expansion operation is the same based on the fact that the profile of the figure which replaced and carried out reduction data processing of the profile of the figure which carried out expansion data processing to the input figure, and the interior and the exterior of an input figure is the same. Therefore, you may calculate the exterior angle of the peak V in the case of an expansion operation, and the interior angle of the peak V in the case of a reduction operation as theta, respectively.
[0056] Thus, an operation of the interior angle or exterior angle theta of the peak V classifies the peak V into the following six classification T1-T6 based on the value of calculated theta (Step 3-7). Namely, as shown at drawing 4 (a) in the case of expansion data processing, as for the peak V, in the case of 0< theta<pi / 2, the interior angle theta of the peak V is considered as classification T1 (Step 3-8). Like the following, as are shown in drawing 4 (b), and the peak V is shown at classification T2 (Step 3-9) and drawing 4 (c) in the case of theta=pi/2 As the peak V is shown at classification T3 (Step 3-10) and drawing 4 (d) in pi / 2< theta<pi As the peak V is shown at classification T4 (Step 3-11) and drawing 4 (e) in the case of pi<theta <3pi/2 As the peak V is shown at classification T5 (Step 3-12) and drawing 4 (f) in the case of theta=3pi/2, in 3pi/2<theta<2pi, it is carried out to classification T6 (Step 3-13), respectively.
[0057] It changes Flag D into a set state as that by which is followed, and the peak V is included [the interior angle theta of the peak V] for the oblique side in the OR-operation figure F in one case of the classification T1, T3, T4, and T6 pi/2 and not 3pi/2 but when the peaks V are not classification T2 and T5 (Step 3-14 - Step 3-17).
[0058] Thus, the result of an operation of the interior angle (or exterior angle) theta of the obtained peak V and the classification T1-T6 to which the peak V was set are registered, respectively (Step 3-18 and 3-19). And it is registered whether the OR-operation figure F into which the classification of all the peaks was registered contains the oblique side (Step 3-20).
[0059] In addition, it is the case where the classification of all the peaks V in an OR-operation figure is T2 and T5 (when it is theta=pi / 2, and theta=3pi/2), and moreover, when all the sides consist of oblique sides, although the OR-operation figure contains the oblique side, it is judged in fact, to be the figure which does not contain an oblique side. However, even if it processes such an OR-operation figure as a figure which does not contain an oblique side as what is made to rotate the figure constituted by only the perpendicular side and the level side which do not contain an oblique side, and is in the inclination state, there is no especially un-arranging.
[0060] Thus, if the classification of all the peaks in the OR-operation figure F is judged and the existence of an oblique side is set up, as shown in Step 1-10 of drawing 1 , it will judge whether the OR-operation figure F contains the oblique side in the state of the set state of Flag D, and reset. And when the OR-operation figure F does not contain the oblique side and the oblique side is included again by Step 1-11 to 1-14 of drawing 1 , the peak of a temporary figure is generated by Step 1-15 to 1-21 of drawing 1 to each peak of the OR-operation figure F, respectively.
[0061] While setting the m-th peak of a peak train to V as shown in Step 1-12 for example, when the OR-operation figure F does not contain the oblique side, the peak of a temporary figure [as opposed to the peak V for each peak contiguous to this peak V] is generated as U and W based on the process A shown in the flow chart of drawing 5 , respectively (Step 1-13).
[0062] Drawing 6 (a) and (b) are explanatory drawings of the process A carried out in order to generate the peak of the temporary figure to the peak V, when the OR-operation figure F does not contain the oblique side. In Process A, the parallel displacement only of the change width of face d is carried out to the perpendicular direction of each sides UV and VW to the exterior of a figure, respectively in the 2 sides UV and VW which in the case of expansion data processing face across the peak V as shown in drawing 6 (a) (Step 5-2). As shown at drawing 6 (b) in the case of a reduction operation, a parallel displacement is carried out to the interior of a figure.
[0063] The detail in this case is shown in the flow chart of drawing 7 . that is, it faces across the peak V -- the exterior (the case of a reduction operation interior of a figure) of a figure is made to carry out the parallel displacement only of the change width of face (vertical distance) d in the case of an expansion operation, and it makes vector U'V' two sides (vector) of one sides UV of UV and VW (Step 7-1 of drawing 7) this -- a case -- an endpoint -- U -- ' -- the side -- UV -- a parallel displacement -- having carried out -- the time -- a vector -- U'V -- ' -- it can set -- the peak -- U -- corresponding -- an endpoint -- it is -- an endpoint -- V -- ' -- the side -- UV -- a parallel displacement -- having carried out -- the time -- a vector -- U'V -- ' -- it can set -- the peak -- V -- corresponding -- an endpoint -- it is . Since [which faces across the peak V] UV and two side of VW(s) are vectorized, respectively as mentioned above, the direction of the exterior and the direction of the interior of a figure are discriminated easily.
[0064] Next, the parallel displacement only of the change width of face (vertical distance) d is carried out to the exterior (or interior) of a figure, and the side (vector) VW of another side which faced across the peak V in the OR-operation figure F is made into side V" W' (Step 7-2 of drawing 7). Endpoint V" in this case It is an endpoint corresponding to the peak V in vector V'W' at the time of carrying out the parallel displacement of the side VW. Endpoint W' is an endpoint corresponding to the peak W in vector V"W' at the time of carrying out the parallel displacement of the side VW.
[0065] thus -- each -- the side (vector) -- UV -- and -- VW -- a parallel displacement -- carrying out -- having -- if -- a parallel displacement -- the back -- each -- a vector -- U'V -- ' -- and -- V -- " -- W -- ' -- drawing 6 -- (-- b --) -- being shown -- as -- crossing -- a case -- **** -- the -- an intersection -- the peak -- V -- receiving -- temporary -- a figure -- the peak -- V -- " -- ' -- ****** -- registering -- a parallel displacement -- carrying out -- having had -- each -- a vector -- U'V -- ' -- and -- V -- " -- W -- ' -- drawing 6 -- (-- a --) -- being shown -- as -- not crossing -- a case -- **** -- each -- a vector -- U'V -- ' -- and -- V -- " -- W -- ' -- respectively -- having extended -- the time -- an intersection -- the peak -- V -- receiving -- temporary -- a figure -- the peak -- V -- " -- ' -- ******
[0066] The peak of the temporary figure corresponding to all the peaks to the OR-operation figure F is set up one by one by carrying out such processing to the turn of a peak train of having met in the direction of a vector, to all the peaks in the OR-operation figure F. And the peak of the set-up temporary figure is registered in order along the direction of a vector, and

let it be the peak train of a temporary figure (Step 5-3).
[0067] On the other hand, when the OR-operation figure F contains the oblique side, it progresses to Step 1-15 of drawing 1 , for example, the m-th peak of a peak train is set to V, and each peak contiguous to this peak V is set to U and W, respectively (Step 1-16). And the attribute of being that in which each peak of the OR-operation figure F receives the influence of an oblique side is judged (Step 1-17).
[0068] The judgment of the attribute of whether the peak V is what is influenced of an oblique side is carried out based on the flow chart shown in drawing 8 . Namely, if the angle theta of the already registered peak V is either of the classification T1 or T3 smaller than pi (Step 8-1) The interior angle theta in the case of an expansion operation A salient (it is smallness from pi), Since the exterior angle theta in the case of a reduction operation is a reentrant angle (it is size from pi), or the peak V The attribute of "P-A" is given to the peak V so that not the thing influenced [especially] of an oblique side but the process A (peak generation process of a temporary figure in case the OR-operation figure F does not contain an oblique side) mentioned above may generate the peak of a temporary figure (Step 8-4).
[0069] On the other hand, the angle theta of the already registered peak V is a larger classification than pi. and when either of the sides of the couple which faces across the peaks U and W, respectively is an oblique side, (Step 8-2 and 8-3), and the peak V as what is influenced of an oblique side The attribute of "P-B" is given to the peak V as what should generate the peak of a temporary figure according to a different process B from the generation method of the peak of the temporary figure by Process A (Step 8-5).
[0070] If this sets to U and W each peak contiguous to the peak V where the interior angle theta turned into a larger reentrant angle than pi as shown in drawing 9 When each sides XU, UV, and WY where the side VW is an oblique side and while facing across the peak V faces across each of other peaks U and W are not oblique sides, respectively, each peaks V and W which constitute the oblique side VW (when it is the level side or the perpendicular side) will be influenced of an oblique side as each endpoint of an oblique side. Moreover, in order that the peak U contiguous to the peak V may share Endpoint V and the side UV of an oblique side VW, it will be influenced of an oblique side. In order that similarly the peak Y contiguous to the peak W may share Endpoint W and the side WY of an oblique side VW, it is influenced of an oblique side VW. Therefore, the peak which is not influenced of an oblique side VW turns into the peaks X and Z contiguous to the peaks U and Y.
[0071] As opposed to one endpoint V of an oblique side VW thus, the influence of the oblique side In order to reach even a pair each of sides XU, UV, VW, and WY which face across the peaks U and W contiguous to the peak V, respectively When it judges whether an oblique side is in a pair each of sides which face across each peaks U and W contiguous to the peak V which is a processing object and there is an oblique side, an attribute "P-B" is given so that the peak V may generate the peak of a temporary figure according to Process B as what is influenced of an oblique side. Process B is shown in the flow chart of drawing 11 , and is mentioned later.
[0072] "-- P-A -- " -- an attribute -- giving -- having had -- the peak -- V -- expansion -- an operation -- a case -- **** -- drawing 10 -- (-- a --) -- being shown -- as -- the peak -- V -- inserting -- two -- a ** -- the side (vector) -- UV -- and -- VW -- change -- width of face (vertical distance) -- d -- only -- the exterior -- a parallel displacement -- carrying out -- making -- a vector -- U'V -- ' -- and -- V'W -- ' -- In the case of a reduction operation, as shown in drawing 10 (b), it considers as the peak of a temporary figure [as opposed to / only the change width of face (vertical distance) d makes the interior carry out the parallel displacement of two sides of UVs and VW(s), consider as vector U'V' and V"W', and / the peak V for those intersection V"'] which faces across the peak V.
[0073] on the other hand, when the classification of the registered vertical angle V has become either T4 or T6 A reentrant angle (it is size from pi) or the exterior angle theta in the case of a reduction operation is a salient (it is smallness from pi). interior angle / theta / in the case of an expansion operation] Furthermore, it judges by whether either of a pair each of sides which face across each peaks U and W which adjoin [whether the peak V is influenced of an oblique side and] the peak V, respectively is an oblique side (Step 8-2). And when a pair each of sides which face across the peaks U and W, respectively are not oblique sides, respectively, as that in which the peak V does not receive the influence of an oblique side, the attribute of "P-A" is given (Step 8-3), and, as for the peak V, the peak of a temporary figure is generated by Process A.
[0074] The peak V where the attribute of "P-A" was given thus, in the case of an expansion operation As shown in drawing 10 (a), in the case of a reduction operation As shown in drawing 10 (b), the 2 sides UV and VW which face across the peak V only the change width of face (vertical distance) d the exterior -- or -- the interior -- a parallel displacement -- carrying out -- making -- a vector -- U'V -- ' -- and -- V"W -- ' -- ** -- carrying out -- those -- an intersection -- V -- " -- ' -- or -- each -- a vector -- U'V -- ' -- and -- V"W -- ' -- extension wire -- an intersection -- V -- " -- ' -- the peak -- V -- receiving -- temporary -- a figure -- the peak -- ** -- carrying out .
[0075] thus -- an OR operation -- a figure -- F -- the peak -- V -- an attribute -- giving -- having -- if -- drawing 1 -- it can set -- a flow chart -- a step -- one -- - -- 18 -- being shown -- as -- the peak -- V -- an attribute -- judging -- having -- the peak -- V -- an attribute -- "-- P-A -- " -- it is -- a case -- **** -- drawing 5 -- being shown -- a flow chart -- being based -- a process -- A -- the peak --
[0076] On the other hand, when the attribute of the peak V of the OR-operation figure F is "P-B", unlike Process A, the three peaks of the temporary figure to the peak V are generated by Process B as what is influenced of an oblique side (Step 1-20).
[0077] Drawing 11 is explanatory drawing of the generation method of the peak of the temporary figure according [the flow chart and drawing 12 which show how to generate the peak of the temporary figure to the peak V of the OR-operation figure F according to Process B] to the process B. in Process B, in carrying out an expansion operation, as shown in drawing 12 (a), it faces across the peak V -- two sides, only the change width of face (vertical distance) d carries out the parallel displacement of UV and the VW to the exterior of the OR-operation figure F, and makes them vector U'V' and vector V"W', respectively (Step 11-1 of drawing 11) in carrying out a reduction operation, as shown in drawing 12 (b), it faces across the peak V -- two sides, only the change width of face (vertical distance) d carries out the parallel displacement of UV and the VW to the interior of a figure, and makes them vector U'V' and vector V"W', respectively Since all the sides of a figure are vectorized so that the interior of a figure may become right-hand side, the direction of the exterior and the direction of the interior of a figure are easily discriminable.
[0078] Thus, although two endpoints V' and V" are obtained to the peak V, these endpoints V' and V" are registered as the

peak of a temporary figure, respectively. In this case, the peak V of the OR-operation figure F is registered as the peak of a temporary figure. temporary -- a figure -- three -- a ** -- the peak -- V -- V -- ' -- V -- " -- as follows -- turn -- registering -- having . That is, since generation of the peak of a temporary figure is carried out in order along the direction of the vector of each vectorized side in an OR-operation figure, while being processed in order of peak U-V-W and processing the peak U in advance of processing of the peak V, the peak W is processed after processing of the peak V. for this reason -- the side -- UV -- a parallel displacement -- having carried out -- the time -- the peak -- V -- corresponding -- an endpoint -- V -- ' -- the peak -- U -- corresponding -- an endpoint -- U -- ' -- the peak -- V -- between -- registering -- having . Endpoint V" corresponding to the peak V at the time of carrying out the parallel displacement of the side VW is registered between endpoint W' and the peaks V corresponding to the peak W. Therefore, as a peak train of a temporary figure, peak V' is registered into the degree of peak U' (Step 11-2), next, the peak V is registered (Step 11-3), and peak V" is registered further after that (Step 11-4). Therefore, as the peak of a temporary figure, it is registered in order of U'-V'-V-V"-W'.

[0079] When the OR-operation figure F obtained when registration of such a peak train of a temporary figure carries out the OR operation of the input figure group S is plurality, the peak train of a temporary figure is generated to each OR-operation figure F so that a temporary figure may be obtained by each OR-operation figure F of every (Step 1-22 of drawing 1 (b)). And a temporary figure is generated by connecting the peak train of all temporary figures to the order by which setting registration was carried out (Step 1-23). When the number of the OR-operation figures F is N, the temporary figure generated also becomes N pieces.

[0080] If all temporary figures are generated, an OR operation will be carried out to a full-temporary figure (Step 1-24). And the figure group which the OR operation was carried out and was obtained is outputted as data S of a LISA IJINGU figure (Step 1-25).

[0081] An OR operation will be carried out by the calculation speed of O (nlogn), if the side sets the total number of the peaks to n to N temporary figures also including intersection.

[0082] If the peak of a temporary figure is registered to all the peaks to the OR-operation figure F shown in drawing 2 (c) based on the flow chart of drawing 1 , one temporary figure 21 shown in drawing 13 (a) will be generated. In this case, although the number of the peaks of the OR-operation figure F was 18, the number of the peaks of the temporary figure 21 is set to 28. And by carrying out the OR operation of the temporary figure 21 shown in drawing 13 (a), the LISA IJINGU (expansion) figure 22 shown in drawing 13 (b) will be obtained, and this figure will be outputted.

[0083] Although classified into "P-A" which should carry out the process A which generates only the one peak of the temporary figure corresponding to the peak V by judging the attribute of whether the peak V is influenced by the oblique side, and "P-B" which should carry out the process B which generates the three peaks of a corresponding temporary figure according to this example The condition judging of a classification of this attribute can be processed at high speed as compared with the machine time which the OR operation which is only carried out for every peak and is carried out after that takes.

[0084] and the figure which does not contain an oblique side -- receiving -- any of the peak -- although -- since the peak of a temporary figure is classified into the attribute of "P-A" by which only one is generated to the one peak, the total number of the peaks of a temporary figure is cut down, and subsequent OR-operation processing can also be carried out at high speed

[0085] In addition, in the above-mentioned example, when the OR-operation figure F has the oblique side, it sets. When larger than pi, as shown in drawing 8 , the classification of the angle of (peak the judgment of whether T4 - T6), and the judgment V of the attribute of the peak, i.e., the peak, are influenced of an oblique side [the angle theta of the peak V] Although it was made to carry out each peaks U and W contiguous to the peak V by whether either of the sides of the couple inserted, respectively is an oblique side For example, you may make it judge the attribute of the peak V based on the angle (classification T1-T6 of the peaks U and W) of the peaks U and W contiguous to the peak V.

[0086] Drawing 14 shows the flow chart in that case. In this case, in case the attribute of the peak V is investigated, [whether the classification of the peak V is either T1-T3, and] Investigate whether it is either T4-T6 (Step 14-1), and when the classification of the peak V is T1-T3 (angle theta<pi of the peak) The peak V is made into the attribute of "P-A" which should be processed according to Process A like the example shown in drawing 8 as what is not influenced of an oblique side (Step 14-4). That is, if the exterior angle theta of the salient smaller than pi or the peak V in the case of a reduction operation is a bigger reentrant angle than pi, it will consider as the attribute of "P-A" and the one peak of a temporary figure will be generated to the peak V. [interior angle / of the peak V in the case of an expansion operation / theta]

[0087] On the other hand, when the classification of the peak V is T4-T6 (angle theta>pi of the peak V), it investigates, respectively whether the classification of the peaks U and W contiguous to the peak V is T1-T3, or it is T4-T6 (Step 14-2 and 14-3). and any of the peaks U and W contiguous to the peak V -- although -- when it is classification T1-T3 (i.e., only when all have the angle of the peaks U and W smaller than pi), the attribute of "P-B" which should process the peak V according to Process B as what is influenced by the oblique side is given (Step 14-5) When one classification of the peaks U and W contiguous to the peak V is T4-T6, the attribute of "P-A" which should be processed according to Process A is given as that in which, as for the peak V, the angle theta of the peaks U and W does not receive the influence of an oblique side in being larger than pi (Step 14-4).

[0088] In the case of this example, the LISA IJINGU (expansion) temporary figure 23 shown in drawing 15 is generated to the OR-operation figure F shown in drawing 2 (c). In this case, the number of the peaks of the temporary figure 23 is set to 30. And the LISA IJINGU (expansion) figure 22 shown in drawing 13 (b) is obtained by carrying out the OR operation of this temporary figure 23.

[0089] Drawing 16 is a flow chart which shows the example of further others of the method of investigating the attribute of the peak V. In this example, the attribute of whether the peak V is influenced of an oblique side is judged based on the sum of the angle of each peaks U and W contiguous to the angle theta of the peak V, and the peak V, and each angle of each peaks U and W which adjoin the peak V further.

[0090] That is, when the classification of the angle of the peak V is T1-T3 (angle theta<pi of the peak), (Step 16-1) and the peak V are made into the attribute of "P-A" like each aforementioned example as what is not influenced of an oblique side as what is not influenced of an oblique side (Step 16-6).

[0091] on the other hand, any of each peaks U and W which adjoin the peak V when the classification of the angle theta of

the peak V is T4 (pi<theta <3pi/2) -- although -- if it is not classification T3 (pi / 2< theta<pi) (Step 16-2 and 16-4), it will consider as the attribute of "P-A" as what is not influenced of the oblique side of the peak V (Step 16-6)
[0092] however, when the classification of the angle theta of the peak V is T4 (pi<theta <3pi/2) and either of each peaks U and W contiguous to the peak V is classification T3 (pi / 2< theta<pi) Only when the sum of the angle of the peaks U or W of classification T3 and the angle of the peak V is larger than 2pi, the peak V is made into the attribute of "P-B" as what is influenced of an oblique side (Step 16-7). When the classification of the angle of the peak V is T4, the attribute of the peak V is made into "P-A" except such a condition.
[0093] Thereby, when carrying out the expansion operation of the OR-operation figure, the interior angle theta of the peak V is a reentrant angle of pi<theta <3pi/2, and moreover one interior angle theta' of the adjoining peaks U or W is the salient of pi/2<theta'<pi, it restricts to the time when it is >(theta+theta') 2pi further, and "P-B" is given as an attribute of the peak V. Therefore, when only the oblique side (45 degrees or 135 degrees) is contained in the OR-operation figure, the combination of the peak V and the peaks U or W with which are satisfied of this condition does not exist, but in this case, the attribute of P-A is given and, as for each peak of an OR-operation figure, every one peak of a temporary figure is generated to each peak.
[0094] If either of each peaks U and W contiguous to the peak V is classification T3 (pi / 2< theta<pi) as shown in drawing 16 (b) when the classification of the angle of the peak V is T5 (theta=3pi/2) (Step 16-8 and 16-9), the attribute of the peak V will be made into "P-B" (Step 16-7). In the case where the classification of the angle of the peak V is T5 (theta=3pi/2), if there is nothing on such conditions, the attribute of the peak V will be made into "P-A" (Step 16-6).
[0095] Thereby, when carrying out the expansion operation of the OR-operation figure, the interior angle theta of the peak V is a reentrant angle of theta=3pi/2, one interior angle theta' of the adjoining peaks U or W restricts to the time when it is the salient of pi/2<theta'<pi, and the peak V is made into the attribute of "P-B" as what is influenced of an oblique side. Therefore, when only the oblique side (45 degrees or 135 degrees) is contained in the OR-operation figure, the angle theta of the peak V is 270 degrees, and only when angle theta' of the peaks U or W is 135 degrees, the three peaks of a temporary figure are generated by Process B as that in which the peak V receives the influence of an oblique side.
[0096] If either of each peaks U and W contiguous to the peak V is classification T2 (theta=pi/2) or T3 (pi / 2< theta<pi) as shown in drawing 16 (c) when the classification of the angle of the peak V is T6 (3pi/2<theta<2pi) (Step 16-10 and 16-12), the attribute of the peak V will be made into "P-B" (Step 16-7). Moreover, if either of each peaks U and W contiguous to the peak V is classification T1 (0< theta<pi / 2) and the sum of the angle of the peaks U or W of classification T1 and the angle of the peak V is larger than 2pi (Step 16-11 and 16-13), the attribute of the peak V will be made into "P-B" (Step 16-7). In the case (3pi/2<theta<2pi) where the classification of the angle of the peak V is T6, if it has not been such conditions, the peak V will be made into the attribute of "P-A" as what is not influenced of an oblique side (Step 16-6).
[0097] By this, in carrying out the expansion operation of the OR-operation figure the interior angle theta of the peak V -- 3pi/2 < -- one interior angle theta' of the peaks U or W which are the reentrant angles of theta<2pi and moreover adjoin -- pi/2<=theta' -- or [that it is the salient of <pi] -- or It restricts to the time when it is >(theta+theta') 2pi in the salient of 02<theta'<pi/2, and the attribute of "P-B" is given as that in which the peak V receives the influence of an oblique side. Therefore, when only the oblique side (45 degrees or 135 degrees) is contained in the OR-operation figure, the peak of three temporary figures is generated by Process B as what is influenced of an oblique side only at the time of angle theta'=135 degree of the time of angle theta'=90 degree of the angle of theta= 315 degrees of the peak V, and the peaks U or W or the angle of theta= 315 degrees of the peak V, and the peaks U or W.
[0098] Although the attribute of the peak V is classified into "P-A" which should carry out the process A which generates only the one peak of a corresponding temporary figure, and "P-B" which should carry out the process B which generates the three peaks of a corresponding temporary figure according to this example, the condition judging of a classification of this attribute can be processed at high speed as compared with the machine time which the OR operation which is only carried out for every peak and is carried out after that takes.
[0099] and -- the case of the figure which does not contain an oblique side -- any of the peak -- although -- the peak of a temporary figure is classified into the attribute of "P-A" by which only one is generated to the one peak Moreover, the figure which contains only an oblique side (45 degrees and 135 degrees) to the level side in addition to the perpendicular side and the level side is also received. The angle (the case of an expansion operation the case of the angle of an interior angle, and a reduction operation angle of an exterior angle) theta of the two continuous peaks, and the combination of theta' theta= 270 degrees and theta'=135 degree, and theta= 315 degrees and theta'=90 degree, In the case of three kinds (theta= 315 degrees and theta'=135 degree), it is restricted, only the peak used as the angle theta is classified into "P-B" so that three may be generated as the peak of a temporary figure, and other peaks are classified into "P-A."
[0100] Therefore, in this example, the number of the peaks of a bird clapper of a temporary figure is very rare for the attribute "P-B" to which the process B by which the peak of three temporary figures is generated to the peak of an OR-operation figure is applied. Consequently, the number of the peaks of a temporary figure can be cut down remarkably, and it becomes possible to shorten remarkably the time which OR-operation processing of a temporary figure takes.
[0101] In the case of this example, the LISA IJINGU (expansion) temporary figure 24 shown in drawing 17 is generated to the OR-operation figure F shown in drawing 2 (c). In this case, to the total 18 peaks of the input figure F, the number of the peaks of the temporary figure 24 is set to 22, and the four peaks are increasing it. And the LISA IJINGU (expansion) figure 22 shown in drawing 13 (b) is obtained by carrying out the OR operation of this temporary figure 24.
[0102] Therefore, in a complicated figure like a circuit pattern with bending [much], when the oblique side is used locally, by this example, the scope of the process B which generates the peak of three temporary figures can be limited, and high-speed processing is attained.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] (a) And (b) is a flow chart which shows an example of the procedure of the LISA IJINGU method of the mask pattern of this invention, respectively.
[Drawing 2] They are the input figure as which (a) is inputted into an example of the mask pattern of LSI, and (b) is inputted into the CAD system of the mask pattern, and the OR-operation figure obtained by (c) carrying out the OR operation of the input figure.
[Drawing 3] In order to judge the classification of the angle of all the peaks of an OR-operation figure, it is the flow chart which shows an example of the procedure of a method.
[Drawing 4] (a) - (f) is explanatory drawing of the classification T1-T6 of the angle of the peak of an OR-operation figure, respectively.
[Drawing 5] It is the flow chart which shows the procedure of the process A which is the generation method of the peak of the temporary figure to the peak of the OR-operation figure when the OR-operation figure does not contain the oblique side.
[Drawing 6] (a) And (b) is explanatory drawing of the generation method of the peak of the temporary figure by Process A, respectively.
[Drawing 7] It is the flow chart which shows an example of the procedure at the time of carrying out the parallel displacement of each side of an OR-operation figure.
[Drawing 8] Each peak of an OR-operation figure is the flow chart which shows an example of a procedure which judges the attribute of being what is influenced of an oblique side.
[Drawing 9] It is explanatory drawing in case the peak in an OR-operation figure is influenced of an oblique side.
[Drawing 10] (a) And explanatory drawing of the generation method of the peak of the temporary figure to the peak which is not influenced of the oblique side in the OR-operation figure containing an oblique side, (b), and (c) of (d) are explanatory drawings of the generation method of the peak of the temporary figure to the peak influenced of the oblique side in the OR-operation figure containing an oblique side, respectively, respectively.
[Drawing 11] It is the flow chart which shows an example of the procedure of the method of generating the peak of the temporary figure to the peak of an OR-operation figure according to Process B.
[Drawing 12] (a) And (b) is explanatory drawing of the generation method of the peak of the temporary figure by the process B, respectively.
[Drawing 13] It is the expansion operation figure obtained by the temporary figure generated based on the flow chart of drawing 1 in the OR-operation figure which shows (a) to drawing 2 (c), and (b) carrying out the OR operation of the temporary figure.
[Drawing 14] Each peak of an OR-operation figure is the flow chart which shows other examples of the procedure of judging the attribute of being what is influenced of an oblique side.
[Drawing 15] It is the temporary figure generated based on the OR-operation figure shown in drawing 2 (c).
[Drawing 16] (a) - (c) is a flow chart which shows the example of further others of the procedure in which each peak of an OR-operation figure judges the attribute of being what is influenced of an oblique side, respectively.
[Drawing 17] It is the temporary figure generated based on the OR-operation figure shown in drawing 2 (c).
[Drawing 18] (a) is [the enlarged-view form and (c of an example of the input figure of a mask pattern and (b))] the similar figure.
[Drawing 19] (a) - (g) is explanatory drawing of expansion data processing of an input figure, or reduction data processing, respectively.
[Drawing 20] It is explanatory drawing of the portion with which an example of the input figure at the time of (a) verifying the minimum spacing of a mask pattern and (b) are not satisfied [with] of the enlarged-view form of the input figure, and (c) is not satisfied of minimum spacing.
[Drawing 21] It is explanatory drawing of the portion with which an example of the input figure at the time of (a) verifying the minimum width of face of a mask pattern and (b) are not satisfied [with] of the reduction figure of the input figure, and (c) is not satisfied of the minimum width of face.
[Drawing 22] It is explanatory drawing of the portion with which an example of the input figure at the time of (a) extracting the field which can be wired, and (b) are satisfied [with] of the enlarged-view form of the input figure, and (c) is satisfied of the field which can be wired.
[Drawing 23] The enlarged-view form of the input figure and (c of an example of the input figure at the time of (a) removing a notch and (b)) are the reduction figures of the enlarged-view type.
[Drawing 24] (a) And (b) is explanatory drawing of an OR operation, respectively.
[Drawing 25] (a) And it is the input figure from which, as for (b), an exact enlarged-view form is not obtained depending on a conventional method 2, respectively.
[Drawing 26] (a) And (b) is a flow chart which shows the procedure of a conventional method 3, respectively.
[Drawing 27] (a) - (c) is explanatory drawing with a required OR operation, respectively.

[Drawing 28] It is a temporary figure [in / the expansion operation of the input figure / (a) with a conventional method 3, and / in (b)]. / an example of the input figure of a mask pattern
[Drawing 29] It is the flow chart which shows the procedure of a conventional method 4.
[Drawing 30] (a) And (b) is the mistaken enlarged-view form generated by the conventional method 4, respectively.
[Description of Notations]
10 Mask Pattern
11 Oblique Side Section
12 Horizontal Level
13 Rectangle Section
14 Vertical Section
15 Horizontal Level
16 Rectangle Section
11' Inclination input figure
12' Level input figure
13' Rectangle input figure
14' Perpendicular input figure
15' Level input figure
16' Rectangle input figure
F OR-operation figure

[Translation done.]

(19) JAPANESE PATENT OFFICE

PATENT ABSTRACTS OF JAPAN

(11) Publication number: **08227431 A**

(43) Date of publication of application: **03.09.96**

(51) Int. Cl **G06F 17/50**
G06T 11/20

(21) Application number: **07033214**

(22) Date of filing: **22.02.95**

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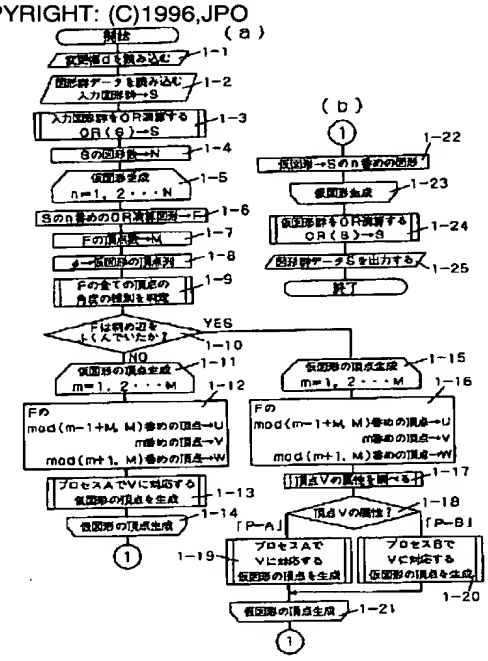
(54) RESIZING METHOD FOR MASK PATTERN

(57) Abstract:

PURPOSE: To perform fast enlarging or reducing arithmetic processing for the input figure of a mask pattern by a CAD system.

CONSTITUTION: It is decided whether or not the input figure has a hypotenuse and when so, it is decided whether or not each vertex is affected by the hypotenuse. When the vertex is affected by the hypotenuse, end points corresponding to vertexes when the pair of the sides of the input figure which contains the vertex are moved to inside or outside the figure in parallel are decided as the vertexes of a temporary figure together with the vertex (step 1-11). When the vertex is not affected by the hypotenuse, the intersections of respective sides when the pair of sides of the input figure that contains the vertex are moved to outside or inside the figure in parallel or the intersections of prolongations of the respective sides that are moved in parallel are regarded as the vertexes of a temporary figure for the vertexes of the input figure (step 1-14). Then the respective vertexes of the temporary figure which are obtained are connected to generate the temporary figure, which is ORed (step 1-24).



(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（Ａ）　(11)特許出願公開番号

特開平8－227431

(43)公開日　平成８年(1996)９月３日

(51)Int.Cl.[6]	識別記号	庁内整理番号	ＦＩ		技術表示箇所
Ｇ０６Ｆ　17/50			Ｇ０６Ｆ　15/60	６５８Ｐ	
Ｇ０６Ｔ　11/20				６２８Ａ	
				６５８Ｒ	
		9365－5H	15/72	３５５Ｋ	

審査請求　未請求　請求項の数４　ＯＬ　（全 24 頁）

(21)出願番号　特願平7－33214

(22)出願日　平成７年(1995)２月22日

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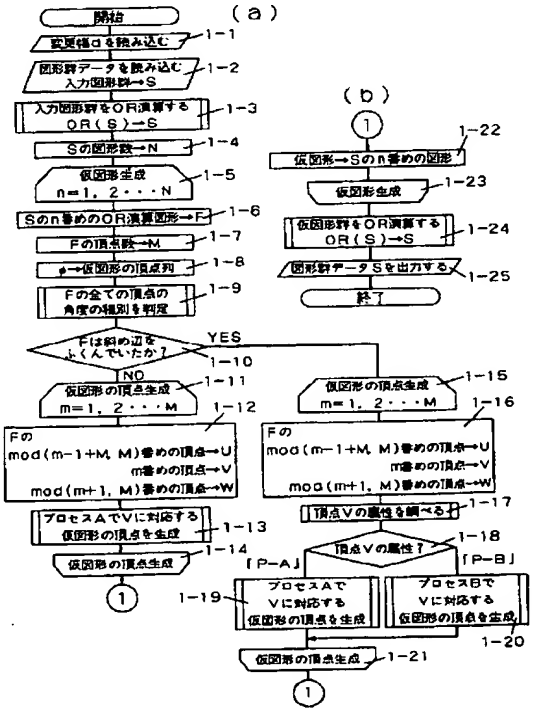
(54)【発明の名称】　マスクパターンのリサイジング方法

(57)【要約】
【目的】ＣＡＤシステムによって、マスクパターンの入力図形を、高速で拡大演算または縮小演算処理する。
【構成】入力図形が斜辺を有するかどうかを判定し、斜辺を有している場合には、その入力図形の頂点毎に、その頂点が斜辺の影響を受けるかどうかを判定する。頂点が斜辺の影響を受ける場合には、その頂点を挟む入力図形の一対の辺を、図形の内部または外部に平行移動した際のその頂点に対応するそれぞれの端点を、その頂点とともに仮図形の頂点とする。頂点が斜辺の影響を受けない場合には、その頂点を挟む入力図形の一対の辺を図形の外部または内部にそれぞれ平行移動した際の各辺の交点、または平行移動した各辺の延長線の交点を、入力図形の頂点に対する仮図形の頂点とする。その後、得られた仮図形の各頂点を結んで仮図形を生成し、生成された仮図形をＯＲ演算する。



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【特許請求の範囲】

【請求項１】　ＣＡＤシステムによって、マスクパターンに対応する入力図形の各辺を、その入力図形の外部または内部に平行移動させて拡大図形または縮小図形を得るマスクパターンのリサイジング方法であって、

前記入力図形が斜辺を含むかどうかを判定する工程と、

その入力図形が斜辺を含んでいる場合には、その入力図形の頂点毎に、その頂点が斜辺の影響を受けるかどうかを判定する工程と、

入力図形の頂点が斜辺の影響を受ける場合に、その頂点を挟む入力図形の一対の辺を、図形の内部または外部に平行移動した際のその頂点に対応するそれぞれの端点を、その頂点とともに仮図形の頂点とする工程と、

入力図形の頂点が斜辺の影響を受けない場合には、その頂点を挟む入力図形の一対の辺を図形の外部または内部にそれぞれ平行移動し、平行移動された各辺の交点または平行移動された各辺の延長線の交点を、入力図形の頂点に対する仮図形の頂点とする工程と、

得られた仮図形の各頂点を結んで仮図形を生成する工程と、

生成された仮図形をＯＲ演算する工程と、

を包含することを特徴とするマスクパターンのリサイジング方法。

【請求項２】　入力図形の各頂点が、斜辺の影響を受けるかどうかを、その頂点に隣接する各頂点を挟む一対の辺に斜辺が含まれているかどうかによって判定することを特徴とする請求項１に記載のマスクパターンのリサイジング方法。

【請求項３】　入力図形の各頂点が、斜辺の影響を受けるかどうかを、その頂点に隣接する各頂点の角度に基づいて判定することを特徴とする請求項１に記載のマスクパターンのリサイジング方法。

【請求項４】　入力図形の各頂点が、斜辺の影響を受けるかどうかを、その頂点の角度と、その頂点に隣接する各頂点の角度と、その頂点の角度と隣接する各頂点それぞれの角度との和とに基づいて判定することを特徴とする請求項１に記載のマスクパターンのリサイジング方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、ＣＡＤ（Computer Aided Design）システムを利用して実施されるマスクパターンを拡大演算処理および縮小演算処理するリサイジング方法に関する。

【０００２】

【従来の技術】ＬＳＩの大規模高集積化に伴って、現在では、ＣＡＤシステムにより、ＬＳＩが設計されている。特に、マスクパターンを対象としたアートワークシステムにおいて、図形演算機能はなくてはならないものになっている。

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【０００３】図形演算の一つとして、マスクパターンの拡大および縮小を行うリサイジング（resizing）は、マスクパターンの最小間隔や最小幅に関する設計規則検証、配線可能領域の抽出、ノッチや突起の除去等に利用されている。この場合のリサイジングは、マスクパターンを入力図形として、その各辺を、図形の外部あるいは内部へ指定された変更幅だけ平行移動して、拡大図形または縮小図形を得る操作のことであり、相似図形を得る操作ではない。

【０００４】例えば、図１８（ａ）に示すようなマスクパターンを入力図形３０として、その入力図形３０の各辺を、図１８（ｂ）に示すように、指定幅ｄだけそれぞれ外部に平行移動させて拡大図形３１を得る操作がリサイジング（拡大演算）であり、図１８（ｃ）に示すように、入力図形３０の各辺をそれぞれ拡大させて相似図形３２を得る操作とは異なる。

【０００５】リサイジングにおける拡大演算（expanding）では、図１９（ａ）に示すように、入力図形３０の各辺から指定幅ｄの範囲にある外部領域３３も、図形の内部として扱うことを基本概念としており、縮小演算（shrinking）では、図１９（ｂ）に示すように、入力図形の各辺から指定幅ｄの範囲にある内部領域３４も図形の外部として扱うことを基本概念としている。拡大演算の場合には、入力図形３０における頂点の内角が凸角（πより小）になっていると、その頂点は、指定幅ｄだけ拡大されることにより円弧状になる。

【０００６】例えば、拡大演算の場合には、図１９（ｃ）に示すように、入力図形３０における内角が凸角になった頂点３０ａは、その頂点を構成する各辺３０ｂおよび３０ｃがそれぞれ平行移動することにより消滅するが、扇形補間図形３５によって補間されることにより、円弧状になる。しかし、マスクパターンでは、円弧状の扇形補間図形３５が存在すると、取扱が困難になることから、図１９（ｄ）に示すように、扇形補間図形３５における円弧部分の両端の各接線と円弧部分とによって囲まれた追加図形３６を扇形補間図形３５に加えて、図１９（ｅ）に示すように、扇形補間図形３５を四角形補間図形３７に変えている。これにより、図１９（ｆ）に示す拡大図形（リサイジング図形）３１が得られる。

【０００７】縮小演算の場合も、同様に、扇形補間図形における円弧部分の両端の各接線と円弧部分とによって囲まれた追加図形を扇形補間図形に加えて構成された四角形補間図形を図形の外部として扱うことにより、図１９（ｇ）に示す縮小図形（リサイジング図形）３８が得られる。

【０００８】このようにして得られたリサイジング図形は、ＩＣのマスクパターンの最小間隔や最小幅に関する規則検証、配線可能領域の抽出、ノッチや突起の除去等に利用される。

【０００９】最小間隔の設計規則検証は、複数のマスク

パターンが指定された最小間隔ｄだけ相互に離れているかどうかを判定するとともに、最小間隔ｄを満たしていない場合にはその部分を特定する処理である。例えば、図２０（ａ）に示すように、相互に平行になった一対のマスクパターンに相当する入力図形４１および４２が、最小間隔ｄを満足しているか否かを検証する場合には、図２０（ｂ）に示すように、各入力図形４１および４２を、最小間隔ｄの１／２の幅で拡大演算し、図２０（ｃ）に示すように、拡大演算されたリサイジング図形４３および４４が相互に重なっている場合には、その重なり部分４５にて、各入力図形４１および４２は最小間隔ｄを満足していないものとして特定する。

【００１０】最小幅検証は、例えば、図２１（ａ）に示すような形状のマスクパターンに相当する図形４６が、最小幅寸法を満足しているか否かを検証する処理であり、マスクパターンに相当する入力図形４６を最小幅寸法ｄの１／２の幅で縮小演算し、図２１（ｂ）に示すように、縮小演算されたリサイジング図形４７が、複数の図形４７ａおよび４７ｂに分離されたら、図２１（ｃ）に示すように、その分離された部分４８が最小幅寸法ｄを満足していないものとして特定する。

【００１１】配線可能領域の抽出は、例えば、図２２（ａ）に示すように、すでに配線されている領域等のように、配線ができない領域を示す３つの入力図形５１、５２、５３を、図２２（ｂ）に示すように、配線幅の１／２と配線最小間隔との和に等しい寸法ｄだけそれぞれ拡大演算し、図２２（ｃ）に示すように、拡大演算された各リサイジング図形５４、５５、５６以外の領域５７を、配線可能領域として抽出する。

【００１２】ノッチまたは突起の除去とは、マスクパターンにおけるノッチの幅寸法（切り欠き部分の間隔）、または、突起の幅が、最低寸法を満足していない場合に、そのノッチ部分または突起部分を除去するものであり、例えば、図２３（ａ）に示すように、ノッチ６１ａを有する入力図形６１の場合には、ノッチ６１ａの最小幅寸法ｄの１／２の寸法で、図形６１を拡大演算し、図２３（ｂ）に示すように、拡大演算されたリサイジグ図形６２を得る。その後、図２３（ｃ）に示すように、拡大演算されたリサイジング図形６２を同じ寸法（ｄ／２）だけ縮小演算する。ノッチ６１ａの幅寸法が、最小幅寸法ｄを満足していない場合には、縮小演算によって得られたリサイジング図形６３は、ノッチ６１ａが除去された状態になる。

【００１３】ＩＣのマスクパターンを構成する図形群を処理する図形演算は、ＩＣの大規模集積化による図形数の増大に伴って、人手処理が困難となり、ＣＡＤシステムで処理されるようになっている。例えば、特開平３－９４７４号公報には、コンピューターを援用した隣接パターン間のオーバーラップを自動的に作成する方法が開示されており、また、特開平６－１９１１０号公報に

は、ＣＡＤデーターを使用して半導体製造用マスクデーターを作成する方法が開示されている。

【００１４】また、膨大な数の図形を処理する必要性から、図形演算には高速なアルゴリズムが各種提案されている。

【００１５】例えば、「A Concurrent pattern Operation Algorithm for VLSI Mask Data(Proc. 18th Design Automation Conference, 1981）」には、図形演算のひとつであるＯＲ演算について報告されている（以下、この報告を従来法１とする）。ＯＲ演算は、図形が１つ以上重なっている領域と、図形が１つもない領域とを隔てる境界線を抽出する演算であり、この報告では、ＯＲ演算実行前の入力図形群の総頂点数をｎとすると、O(n log n)の計算複雑度でＯＲ演算後の図形群を得ることができる。

【００１６】ＯＲ演算の一例を、図２４に示す。図２４（ａ）に示すように、小さな正方形の入力図形６５と、大きな正方形の入力図形６６と、この大きな正方形の入力図形６６に一部が重なった長方形の入力図形６７と、さらに、小さな長方形の開口部を示す入力図形６８とをＯＲ演算する場合には、各入力図形６５～６８の全ての辺をベクトル化する。本例では、便宜的に図形の内部が右側になるように各辺をベクトル化しており、従って、開口部の入力図形６８の各辺は、開口部の内部が左側になるようにベクトル化される。そして、ベクトルの向きから入力図形６５～６８の重なり数を得て、重なり数が１以上の部分が取り出される。通常、開口部でない１つの入力図形の重なり数は１であり、図形の外側は０である。また、２つの入力図形が重なっている部分では、重なり数は２であり、開口部は重なり数が－１になる。ＯＲ演算の結果、図２４（ｂ）に示す図形が得られ、負になった開口部の入力図形６８は消滅する。

【００１７】また、図形の拡大および縮小演算に関しては、「An O(n log n)algorithm forLSI layout resizing problems（ISCAS '85,1985）」に報告されている（以下、この報告を従来法２とする）。この報告では、Ｘ方向の拡大または縮小とＹ方向の拡大または縮小とを別個に行うことにより、リサイジング図形を得るようになっている。

【００１８】このために、入力図形群の総頂点数をｎとすると、理論的には、O(n log n)の計算複雑度にて処理できるが、Ｘ方向とＹ方向との拡大または縮小が別個に実施されるために、処理時間の高速化が困難であるという問題がある。

【００１９】しかも、基本的にはＸ方向およびＹ方向に平行な水平辺および垂直辺のみからなる図形を対象としているために、Ｘ軸に対して４５°または１３５°の角度の斜辺を有する入力図形でもリサイジング処理は可能であるが、斜辺の処理が複雑になる。例えば、図２５（ａ）に示すように、一対の斜辺７１および７２の間に

短い水平辺７３を有するような入力図形７０や、図２５（ｂ）に示すように、斜辺７４と水平辺７５との間に短い垂直辺７６を有するような入力図形７７を、水平辺７３および垂直辺７６の長さよりも大きな変更幅で拡大演算する場合には、正確なリサイジング図形が得られない。各図形の正確な拡大演算処理図形は、図２５（ａ）および（ｂ）に一点鎖線で示すように、水平辺７３および垂直辺７６に対応する辺がそれぞれ消滅した状態になる。このような正確な拡大演算処理図形を得るためには、各辺のＸ方向およびＹ方向の拡大処理に、さらに、水平辺７３を挟む一対の斜辺７１および７２の交点計算、垂直辺７６を挟む斜辺７４および垂直辺７５の交点計算が、それぞれ必要になる。従って、このような複雑な処理を追加しなければ正確なリサイジング図形を得ることができず、処理時間を高速化することは容易ではない。

【００２０】さらに、「任意角度辺を含むＬＳＩパターンの拡大・縮小手法（情報処理学会研究報告DA43-4，1988-7）」には、任意角度辺からなる入力図形を対象として、リサイジング図形を得るために、中間的な仮図形を生成し、生成された仮図形をＯＲ演算することにより、リサイジング図形を得る方法が開示されている（以下、これを従来法３とする）。

【００２１】この従来法３のフローチャートを図２６に示す。この従来法３では、まず、変更幅ｄを読み込むと（図２６（ａ）のステップ２６－１、以下同様）、複数の入力図形からなる入力図形群Ｓを読み込む（ステップ２６－２）。そして、読み込まれた入力図形群ＳをＯＲ演算する（ステップ２６－３）。

【００２２】マスクパターンが複数の図形によって構成された図形群として入力される場合には、マスクパターンを拡大演算処理または縮小演算処理する前に、ＯＲ演算が必要になる。例えば、図２７（ａ）に示すマスクパターン８０を、図２７（ｂ）に示すように３つの矩形の入力図形８１、８２、８３として入力された場合に、ＯＲ演算処理することなく拡大演算処理すると、図２７（ｃ）に示すように、全ての入力図形８１、８２、８３が拡大演算処理されるために、各入力図形８１、８２、８３に対する拡大図形８１’、８２’、８３’が得られ、これらの拡大図形８１’、８２’、８３’をＯＲ演算処理しても、正確なリサイジング図形が得られない。このために、マスクパターンが複数の図形にて構成された図形群にて入力される場合には、その入力図形群に対してＯＲ演算が必要になる。

【００２３】その後、入力図形群のＯＲ演算処理後の図形数をＮとして（ステップ２６－４）、Ｎ個の入力図形の全てに対して仮図形を生成する（ステップ２６－５～２６－１８）。

【００２４】仮図形の生成に際して、ｎ番目の入力図形をＦとして（ステップ２６－６）、その入力図形Ｆの頂点数をＭとし（ステップ２６－７）、全ての頂点を頂点列として方向付けて、各辺をベクトル化する（ステップ２６－８）。そして、全ての頂点に対して仮図形の頂点を生成する（ステップ２６－９～２６－１６）。

【００２５】仮図形の頂点は、入力図形Ｆにおける頂点列のｍ番目の頂点をＶ、その頂点Ｖのベクトルの方向とは反対側に隣接する頂点をＵ、頂点Ｖのベクトル方向に隣接する頂点をＷとし（ステップ２６－１０）、リサイジングが拡大演算か縮小演算かを判断する（ステップ２６－１１）。そして、リサイジングが拡大演算の場合には、頂点Ｖの内角が凸角（πよりも小）か、凹角（πよりも大）かを判定する（ステップ２６－１２）。頂点Ｖの内角が凸角の場合には、頂点Ｖを挟む一対の辺ＵＶおよびＶＷをそれぞれ変更幅ｄだけＯＲ演算図形の外部に平行移動して得られる各ベクトルまたはそれらの延長線の交点を仮図形の頂点とする（ステップ２６－１４）。このような仮図形の頂点の生成方法をプロセスＡとする。

【００２６】また、リサイジングが拡大演算であって、頂点Ｖの内角が凹角の場合には、頂点Ｖを挟む一対の辺ＵＶおよびＶＷをそれぞれ変更幅ｄだけＯＲ演算図形の外部に平行移動して得られる各ベクトルＵ’Ｖ’およびＶ”Ｗ’の頂点Ｖに対応するそれぞれの端点Ｖ’およびＶ”と、入力図形の頂点Ｖとを、Ｖ’、Ｖ、Ｖ”の順に、それぞれ、仮図形の頂点として登録する（ステップ２６－１５）。このような仮図形の頂点の生成方法をプロセスＢとする。

【００２７】リサイジングが縮小演算の場合にも、頂点Ｖの内角が凸角（πよりも小）か、凹角（πよりも大）かを判定し（ステップ２６－１３）、拡大演算の場合とは逆に、頂点Ｖの内角が凹角の場合には、プロセスＡによって、頂点Ｖを挟む一対の辺ＵＶおよびＶＷをそれぞれ変更幅ｄだけＯＲ演算図形の内部に平行移動して得られるベクトルまたはそれらの延長線の交点を仮図形の頂点とする（ステップ２６－１４）。リサイジングが縮小演算であって、頂点Ｖの内角が凸角の場合には、プロセスＢによって、頂点Ｖを挟む一対の辺ＵＶおよびＶＷをそれぞれ変更幅ｄだけＯＲ演算図形の内部に平行移動して得られる各ベクトルＵ’Ｖ’およびＶ”Ｗ’の頂点Ｖに対応する端点Ｖ’およびＶ”と、ＯＲ演算図形の頂点Ｖとを、Ｖ’、Ｖ、Ｖ”の順に、それぞれ、仮図形の頂点として登録する（ステップ２６－１５）。

【００２８】このような仮図形の頂点の生成を、ＯＲ演算によって生じた全ての図形に対して実施し（ステップ２６－１７）、仮図形の登録された頂点を順番に結ぶことにより、仮図形が生成される（ステップ２６－１８）。そして、生成された仮図形をＯＲ演算して（ステップ２６－１９）、ＯＲ演算された図形がリサイジング図形Ｓとして出力される（ステップ２６－２０）。仮図形は、辺が交差した状態になっているが、ＯＲ演算によ

り、正確なリサイジング図形とされる。

【００２９】この従来法３では、例えば、図２８（ａ）に示すように、頂点数が１８の入力図形８４の場合には、図２８（ｂ）に示すように、頂点数が３２の仮図形８５とされる。

【００３０】このような演算処理方法では、Ｘ方向またはＹ方向のいずれか一方向の処理によって、斜辺を含んでいても、誤りのない正確なリサイジング図形を得ることができる。また、ＯＲ演算図形の各頂点を辺に沿って順番に処理し、ＯＲ演算図形を一周することにより終了するために、O(n)の手数で簡単に処理することができる。さらに、辺の交差処理のために実施されるＯＲ演算に、従来法１を採用することにより、従来法２のＯＲ演算の場合と同様に、O(n log n)の計算複雑度を実現できる。しかも、内部のデーター構造が線形リストになるために、従来法２のように、内部データーが線形リストになっていない場合よりも高速で処理することが可能になる。

【００３１】

【発明が解決しようとする課題】従来法３では、仮図形は、O(n log n)の計算複雑度で生成されるために、処理全体の計算時間は、仮図形のＯＲ演算に要する時間がほとんどである。しかしながら、仮図形の頂点の生成に際して、入力図形の頂点が凸角か凹角かだけを判定して、仮図形の頂点を１つだけ生成するプロセスＡとするか、頂点を３つ生成するプロセスＢとするようになっているために、拡大演算（または縮小演算）時に入力図形の頂点が凹角（または凸角）になっていると、その頂点に対応する仮図形の頂点として３つが生成されることになる。その結果、仮図形の頂点数が多くなり、仮図形のＯＲ演算に長時間を要するという問題がある。

【００３２】仮図形の総頂点数を削減する方法として、仮図形の頂点の生成を、従来法３のプロセスＡだけを適用することにより、入力図形の各頂点に対して１つの仮図形の頂点を生成することも考えられる。以下、これを従来法４とし、そのフローチャートを図２９に示す。図２９のフローチャートでは、仮図形の全ての頂点を、前述のプロセスＡによって生成するようになっており（ステップ２９－１１）、他のステップは、図２６に示す従来法３のフローチャートと同様である。

【００３３】この従来法４での仮図形の各頂点の生成方法は、頂点を挟む２辺を指定幅ｄだけ平行移動して、平行移動された各辺の交点、または、平行移動された各辺の延長線の交点を仮図形の頂点とするものである。従って、入力図形の１つの頂点に対して仮図形の１つの頂点が生成される。そして、仮図形の頂点を順番に結ぶことにより、仮図形が生成される。従って、入力図形に斜辺が含まれており、しかも、拡大演算時に凹角（または縮小演算時に凸角）になった入力図形の頂点数が多い場合にも、仮図形の総頂点数は、従来法３に比べて少なくすることができ、ＯＲ演算に要する時間も短縮される。

【００３４】しかし、図３０（ａ）に示すように、複数の四角形からなる入力図形８６が斜辺を有する場合には、一点鎖線で示す拡大演算図形８７が得られ、本来、図形の内部として扱われるべき部分８７ａが、図形の外部として認識されるために、誤った仮図形が生成される。同様に、図３０（ｂ）に示すように斜辺を有する入力図形８８の場合にも、拡大演算図形８９は、図形の内部として扱われるべき部分８９ａが図形の外部として認識された誤った仮図形が生成される。

【００３５】本発明は、このような問題を解決するものであり、その目的は、ＩＣのマスクパターンを構成する図形が斜辺を含んでいる場合にも、正確なリサイジング図形を、高速で得ることができるマスクパターンのリサイジング方法を提供することにある。

【００３６】

【課題を解決するための手段】本発明のマスクパターンのリサイジング方法は、ＣＡＤシステムによって、マスクパターンに対応する入力図形の各辺を、その入力図形の外部または内部に平行移動させて拡大図形または縮小図形を得るマスクパターンのリサイジング方法であって、前記入力図形が斜辺を含むかどうかを判定する工程と、その入力図形が斜辺を含んでいる場合には、その入力図形の頂点毎に、その頂点が斜辺の影響を受けるかどうかを判定する工程と、入力図形の頂点が斜辺の影響を受ける場合に、その頂点を挟む入力図形の一対の辺を、図形の内部または外部に平行移動した際のその頂点に対応するそれぞれの端点を、その頂点とともに仮図形の頂点とする工程と、入力図形の頂点が斜辺の影響を受けない場合には、その頂点を挟む入力図形の一対の辺を図形の外部または内部にそれぞれ平行移動し、平行移動された各辺の交点または平行移動された各辺の延長線の交点を、入力図形の頂点に対する仮図形の頂点とする工程と、得られた仮図形の各頂点を結んで仮図形を生成する工程と、生成された仮図形をＯＲ演算する工程と、を包含することを特徴とするものであり、そのことにより上記目的が達成される。

【００３７】なお、入力図形の各頂点が、斜辺の影響を受けるかどうかを、その頂点に隣接する各頂点を挟む一対の辺に斜辺が含まれているかどうかによって、あるいは、その頂点に隣接する各頂点の角度に基づいて、あるいは、その頂点の角度と、その頂点に隣接する各頂点の角度と、その頂点の角度と隣接する各頂点それぞれの角度との和とに基づいて、判定することが好ましい。

【００３８】

【作用】本発明のマスクパターンのリサイジング方法では、まず、マスクパターンに相当する入力図形の各辺に、斜辺が含まれているかどうかを判定し、斜辺が含まれている場合には、入力図形の各頂点が、斜辺の影響をうけるかどうかを判定する。そして、斜辺の影響を受け

ない頂点の場合には、その頂点を挟む一対の辺を、拡大演算の場合には図形の外部、縮小演算の場合には図形の内部に、それぞれ平行移動し、平行移動された各辺の交点、または、各辺の延長線の交点を、仮図形の頂点とする。従って、この場合には、１つの頂点に対して仮図形の頂点は、１つ生成される。頂点が斜辺の影響を受ける場合には、その頂点を挟む一対の辺を、拡大演算の場合には図形の外部、縮小演算の場合には図形の内部に、それぞれ平行移動し、平行移動された各辺における頂点に対応する各端点それぞれと、もとの入力図形の頂点との３つを、仮図形の頂点として設定する。

【００３９】仮図形の頂点が設定されると、各頂点を結んで仮図形を生成し、ＯＲ演算することにより、リサイジング図形が得られる。

【００４０】入力図形における各頂点は、その頂点に隣接する各頂点を挟むそれぞれ一対の辺のいずれかが斜辺であれば、斜辺の影響を受けるものとされるが、ＩＣのマスクパターンでは、通常、斜辺は図形の一部にしか利用されないために、３つの仮図形の頂点を生成するプロセスが採用されることは稀であり、仮図形の総頂点数を削減することができる。その後のＯＲ演算に要する時間を短縮できて、処理の高速性が高められる。

【００４１】また、入力図形の頂点が斜辺の影響を受けるかどうかを、その頂点に隣接する各頂点の角度に基づいて判定することにより、３つの仮図形の頂点を生成するプロセスが採用されることが減少し、図形処理の高速性が高められる。さらに、入力図形の頂点が斜辺の影響を受けるかどうかを、その頂点の角度と、その頂点に隣接する各頂点の角度と、その頂点の角度と隣接する各頂点それぞれの角度との和とに基づいて判定することにより、３つの仮図形の頂点を生成するプロセスの適用範囲がさらに限定されて、図形処理は一層、高速化される。

【００４２】

【実施例】以下、本発明の実施例を図面に基づいて詳細に説明する。

【００４３】本発明のマスクパターンのリサイジング方法は、ＬＳＩのマスクパターンの検証等のために、ＣＡＤ（Computer Aided Design）システムにより、マスクパターンを入力図形として、その入力図形の各辺を図形の外部あるいは内部へ指定された変更幅だけ平行移動することにより拡大図形または縮小図形を得る方法である。

【００４４】図１は、本発明のマスクパターンのリサイジング方法の一例を示すフローチャートである。本実施例では、まず、図１（ａ）に示すように、ＣＡＤシステムに入力されるマスクパターンを拡大演算処理または縮小演算処理（リサイジング処理）する際の各辺の変更幅ｄが入力される（図１のステップ１－１参照、以下同様）。この場合、入力図形を拡大するときの変更幅を正、縮小するときの変更幅を負とする。

【００４５】次に、リサイジングの対象となるＬＳＩのマスクパターンのデーターが、Ｘ－Ｙ座標で入力される（ステップ１－２）。

【００４６】図２（ａ）は、入力されるマスクパターンの一例を示している。このマスクパターン１０は、中央部に４５度に傾斜する斜辺部１１を有しており、その斜辺部１１の上側の端部から横長の長方形状の水平部１２が水平方向に延出している。この水平部１２の先端部には、一辺の長さが水平部１２の幅寸法よりも大きな正方形状の矩形部１３が連続している。また、斜辺部１１の下側の端部には、短い縦長の長方形状の垂直部１４が垂直に延出しており、その垂直部の下端部に横長の長方形状の水平部１５が水平に延出している。そして、水平部１５の先端部に、一辺の長さが水平部１５の幅寸法よりも大きな正方形状の矩形部１６が連続している。

【００４７】このようなマスクパターン１０は、ＣＡＤシステムに図形入力される際に、複数の図形の集合体とされる。すなわち、図２（ａ）に示すマスクパターン１０は、図２（ｂ）に示すように、傾斜状態になった長方形状の傾斜入力図形１１’と、この傾斜入力図形１１’の上側の端部に、一方の端部が重なった横長の長方形状の水平入力図形１２’と、この水平入力図形１２’の他方の端部に重なった正方形状の矩形入力図形１３’と、この斜辺入力図形１１’の他方の端部に上端部が重なった縦長の垂直入力図形１４’と、この垂直入力図形１４’の下部に、一方の端部が重なった横長の長方形状の水平入力図形１５’と、この水平入力図形１５’の他方の端部に重なった正方形状の矩形入力図形１６’として、ＣＡＤシステムに入力される。各入力図形１１’～１６’は、水平方向をＸ方向、垂直方向をＹ方向として、また、各入力図形１１’～１６’のそれぞれの辺が、ベクトル化されて読み込まれる。

【００４８】入力図形１１’～１６’の各辺のベクトルは、本実施例では、便宜的に、図形の内側が右側になるように方向付けされている。ＣＡＤシステムに読み込まれた６個の入力図形１１’～１６’は、入力図形群Ｓとされる。

【００４９】６個の入力図形１１’～１６’が読み込まれると、読み込まれた入力図形群Ｓが、図形演算の一つであるＯＲ演算される（ステップ１－３）。ＯＲ演算とは、各入力図形１１’～１６’のそれぞれの辺をベクトル表示した際に、ベクトルの向きから図形の内側と外側を判断することにより、入力図形１１’～１６’が複数の図形の重なりであるかどうかを検出し、重なり数が１以上の図形部分を取り出すパターン論理演算である。

【００５０】図２（ｂ）に示す入力図形群ＳをＯＲ演算すると、図２（ｃ）に示すように、マスクパターン１０の輪郭に沿ったＯＲ演算図形Ｆが得られることになる。このようにして得られるＯＲ演算図形Ｆの全ての辺は、図形の内部が右側となるようにベクトル化されている。

そして、ベクトルが閉鎖されて生成されるＯＲ演算図形Ｆの数が「Ｎ」として登録される（ステップ１－４）。本実施例では、ＯＲ演算によって生成されたＯＲ演算図形Ｆの数Ｎは１である。

【００５１】次に、ＯＲ演算によって生成されたＯＲ演算図形Ｆ毎に番号ｎ（１～Ｎ）が付されて、各ＯＲ演算図形Ｆ毎に、正確なリサイジング図形を得るための中間的な仮図形が生成される（ステップ１－５～ステップ１－２３）。

【００５２】仮図形の生成は以下のようにして実施される。すなわち、ＯＲ演算によって生成された各ＯＲ演算図形Ｆ毎に、頂点の数Ｍを計数して（ステップ１－６およびステップ１－７）、仮図形の頂点列の集合を空集合に初期化する（ステップ１－８）。

【００５３】次に、処理の対象とされている各ＯＲ演算図形Ｆの全ての頂点について、それぞれの角度を算出して、角度の種別を判定することにより、処理対象のＯＲ演算図形Ｆに斜辺が含まれているかどうかを判定する（ステップ１－９）。

【００５４】処理対象になっているＯＲ演算図形Ｆの全ての頂点の角度の種別の判定は、図３のフローチャートに詳細に示されている。すなわち、まず、ＣＡＤシステムは、ＯＲ演算図形Ｆが斜辺を含むかどうかを示すフラグＤを、斜辺を含んでいない「ＮＯ」の初期状態に設定して（ステップ３－１）、ＯＲ演算図形ＦにおけるＭ個の頂点に対して、それぞれ順番に、角度の種別が判定される（ステップ３－２～ステップ３－２０）。

【００５５】ＯＲ演算図形Ｆの全ての頂点は、登録された頂点列の順番に判別され、例えば、ｍ番目の頂点をＶとすると（ステップ３－３）、その頂点Ｖの角度の種別を判定する際に、まず、リサイジング処理が拡大演算であるか縮小演算であるかを判別する（ステップ３－４）。リサイジング処理が拡大演算の場合には、その頂点Ｖの内角がθとして算出され（ステップ３－５）、縮小演算の場合には、頂点Ｖの外角がθとして算出される（ステップ３－６）。これは、入力図形に対して拡大演算処理した図形の輪郭と、入力図形の内部と外部とを入れ換えて縮小演算処理した図形の輪郭とが同じであるという事実に基づき、拡大演算における頂点Ｖの内角が、縮小演算における頂点Ｖの外角と同じ性質を有していることに着目している。従って、拡大演算の場合における頂点Ｖの外角、および縮小演算の場合における頂点Ｖの内角を、それぞれθとして演算してもよい。

【００５６】このようにして頂点Ｖの内角または外角θが演算されると、演算されたθの値に基づいて、頂点Ｖは、例えば以下の６つの種別Ｔ１～Ｔ６に分類される（ステップ３－７）。すなわち、拡大演算処理の場合において、図４（ａ）に示すように、頂点Ｖの内角θが、$0<\theta<\pi/2$の場合には、頂点Ｖは種別Ｔ１とされる（ステップ３－８）。以下同様に、図４（ｂ）に示すように、$\theta=\pi/2$の場合には頂点Ｖは種別Ｔ２（ステップ３－９）、図４（ｃ）に示すように、$\pi/2<\theta<\pi$の場合には頂点Ｖは種別Ｔ３（ステップ３－１０）、図４（ｄ）に示すように、$\pi<\theta<3\pi/2$の場合には頂点Ｖは種別Ｔ４（ステップ３－１１）、図４（ｅ）に示すように、$\theta=3\pi/2$の場合には頂点Ｖは種別Ｔ５（ステップ３－１２）、図４（ｆ）に示すように、$3\pi/2<\theta<2\pi$の場合には種別Ｔ６（ステップ３－１３）とそれぞれされる。

【００５７】頂点Ｖの内角θが$\pi/2$および$3\pi/2$でなく、従って、頂点Ｖは種別Ｔ２およびＴ５でない場合、すなわち、頂点Ｖが種別Ｔ１、Ｔ３、Ｔ４、Ｔ６のいずれかの場合には、ＯＲ演算図形Ｆに斜辺が含まれているものとして、フラグＤがセット状態にされる（ステップ３－１４～ステップ３－１７）。

【００５８】このようにして、得られた頂点Ｖの内角（あるいは外角）θの演算結果と、頂点Ｖの設定された種別Ｔ１～Ｔ６とが、それぞれ登録される（ステップ３－１８および３－１９）。そして、全ての頂点の種別が登録されたＯＲ演算図形Ｆが斜辺を含んでいるかどうかが登録される（ステップ３－２０）。

【００５９】なお、ＯＲ演算図形における全ての頂点Ｖの種別がＴ２およびＴ５の場合（$\theta=\pi/2$および$\theta=3\pi/2$の場合）であって、しかも、全ての辺が斜辺で構成されているような場合には、そのＯＲ演算図形は実際には斜辺を含んでいるにもかかわらず、斜辺を含まない図形と判定される。しかし、このようなＯＲ演算図形は、斜辺を含まない垂直辺および水平辺だけによって構成された図形を回転させて傾斜状態になっているものとして、斜辺を含まない図形として処理しても特に不都合はない。

【００６０】このようにして、ＯＲ演算図形Ｆにおける全ての頂点の種別が判定されて、斜辺の有無が設定されると、図１のステップ１－１０に示すように、ＯＲ演算図形Ｆが斜辺を含んでいるかどうかを、フラグＤのセット状態およびリセット状態で判定される。そして、ＯＲ演算図形Ｆが斜辺を含んでいない場合には、図１のステップ１－１１～１－１４により、また、斜辺を含んでいる場合には、図１のステップ１－１５～１－２１により、それぞれ、ＯＲ演算図形Ｆの各頂点に対して仮図形の頂点が生成される。

【００６１】ＯＲ演算図形Ｆが斜辺を含んでいない場合には、ステップ１－１２に示すように、例えば頂点列のｍ番目の頂点をＶとするとともに、この頂点Ｖに隣接する各頂点を、それぞれＵおよびＷとして、頂点Ｖに対する仮図形の頂点を、図５のフローチャートに示すプロセスＡに基づいて生成する（ステップ１－１３）。

【００６２】図６（ａ）および（ｂ）は、ＯＲ演算図形Ｆが斜辺を含んでいない場合に、頂点Ｖに対する仮図形の頂点を生成するために実施されるプロセスＡの説明図

である。プロセスＡでは、拡大演算処理の場合には、図６（ａ）に示すように、頂点Ｖを挟む２辺ＵＶおよびＶＷを、各辺ＵＶおよびＶＷの垂直方向に変更幅ｄだけそれぞれ図形の外部に平行移動される（ステップ５－２）。縮小演算の場合には、図６（ｂ）に示すように、図形の内部に平行移動される。

【００６３】この場合の詳細を、図７のフローチャートに示す。すなわち、頂点Ｖを挟む２辺（ベクトル）ＵＶおよびＶＷの一方の辺ＵＶを、変更幅（垂直距離）ｄだけ、拡大演算の場合には図形の外部（縮小演算の場合には図形の内部）に平行移動させて、ベクトルＵ’Ｖ’とする（図７のステップ７－１）。この場合の端点Ｕ’は、辺ＵＶを平行移動した際のベクトルＵ’Ｖ’における頂点Ｕに対応する端点であり、端点Ｖ’は、辺ＵＶを平行移動した際のベクトルＵ’Ｖ’における頂点Ｖに対応する端点である。頂点Ｖを挟む２辺ＵＶおよびＶＷは、前述したように、それぞれベクトル化されているために、図形の外部方向および内部方向は容易に識別される。

【００６４】次に、ＯＲ演算図形Ｆにおける頂点Ｖを挟んだ他方の辺（ベクトル）ＶＷが、変更幅（垂直距離）ｄだけ、図形の外部（または内部）に平行移動されて、辺Ｖ”Ｗ’とされる（図７のステップ７－２）。この場合の端点Ｖ”は、辺ＶＷを平行移動した際のベクトルＶ’Ｗ’における頂点Ｖに対応する端点である。端点Ｗ’は、辺ＶＷを平行移動した際のベクトルＶ”Ｗ’における頂点Ｗに対応する端点である。

【００６５】このようにして、各辺（ベクトル）ＵＶおよびＶＷが平行移動されると、平行移動後の各ベクトルＵ’Ｖ’およびＶ”Ｗ’が、図６（ｂ）に示すように、交差する場合には、その交点が、頂点Ｖに対する仮図形の頂点Ｖ”’として登録される。平行移動された各ベクトルＵ’Ｖ’およびＶ”Ｗ’が、図６（ａ）に示すように、交差しない場合には、各ベクトルＵ’Ｖ’およびＶ”Ｗ’をそれぞれ延長した際の交点が、頂点Ｖに対する仮図形の頂点Ｖ”’として登録される（図５のステップ５－２）。

【００６６】ＯＲ演算図形Ｆにおける全ての頂点に対して、ベクトルの方向に沿った頂点列の順番に、このような処理をすることにより、ＯＲ演算図形Ｆに対する全ての頂点に対応した仮図形の頂点が順次設定される。そして、設定された仮図形の頂点は、ベクトルの方向に沿って順番に登録されて、仮図形の頂点列とされる（ステップ５－３）。

【００６７】これに対して、ＯＲ演算図形Ｆが斜辺を含んでいる場合には、図１のステップ１－１５に進み、例えば、頂点列のｍ番目の頂点をＶとし、この頂点Ｖに隣接する各頂点を、それぞれＵおよびＷとする（ステップ１－１６）。そして、ＯＲ演算図形Ｆの各頂点が、斜辺の影響を受けるものかどうかの属性が判定される（ステップ１－１７）。

【００６８】頂点Ｖが斜辺の影響を受けるものであるかどうかの属性の判定は、図８に示すフローチャートに基づいて実施される。すなわち、すでに登録された頂点Ｖの角度θがπよりも小さい種別Ｔ１またはＴ３のいずれかであれば（ステップ８－１）、拡大演算の場合における内角θが凸角（πより小）、あるいは、縮小演算の場合における外角θが凹角（πより大）であるために、頂点Ｖは、特に斜辺の影響を受けるものではなく、前述したプロセスＡ（ＯＲ演算図形Ｆが斜辺を含まない場合の仮図形の頂点生成プロセス）によって仮図形の頂点を生成するように、その頂点Ｖに対して「Ｐ－Ａ」の属性が付与される（ステップ８－４）。

【００６９】これに対して、すでに登録された頂点Ｖの角度θがπよりも大きい種別であり、しかも、頂点ＵおよびＷをそれぞれ挟む一対の辺のいずれかが斜辺である場合には（ステップ８－２および８－３）、頂点Ｖは斜辺の影響を受けるものとして、プロセスＡによる仮図形の頂点の生成方法とは異なるプロセスＢによって仮図形の頂点を生成すべきものとして、その頂点Ｖに「Ｐ－Ｂ」の属性が付与される（ステップ８－５）。

【００７０】これは、例えば、図９に示すように、内角θがπより大きい凹角になった頂点Ｖに隣接する各頂点をＵおよびＷとすると、頂点Ｖを挟む一方の辺ＶＷが斜辺であり、他の各頂点ＵおよびＷを挟む各辺ＸＵ、ＵＶ、ＷＹがそれぞれ斜辺でない場合（水平辺または垂直辺の場合）には、その斜辺ＶＷを構成する各頂点ＶおよびＷは、斜辺の各端点として斜辺の影響を受けることになる。また、頂点Ｖに隣接する頂点Ｕは、斜辺ＶＷの端点Ｖと辺ＵＶを共有することになるために斜辺の影響を受けることになる。同様に、頂点Ｗに隣接する頂点Ｙも、斜辺ＶＷの端点Ｗと辺ＷＹを共有することになるために、斜辺ＶＷの影響を受ける。従って、斜辺ＶＷの影響を受けない頂点は、頂点ＵおよびＹに隣接する頂点ＸおよびＺになる。

【００７１】このように、斜辺ＶＷの一方の端点Ｖに対して、その斜辺の影響は、頂点Ｖに隣接する頂点ＵおよびＷをそれぞれ挟む各一対の辺ＸＵ、ＵＶ、ＶＷ、ＷＹにまで及ぶために、処理対象になっている頂点Ｖに隣接する各頂点ＵおよびＷを挟む各一対の辺に斜辺があるかどうかを判定して、斜辺がある場合には、頂点Ｖは斜辺の影響を受けるものとして、プロセスＢによって、仮図形の頂点を生成するように、属性「Ｐ－Ｂ」が付与される。プロセスＢは、図１１のフローチャートに示されており、後述する。

【００７２】「Ｐ－Ａ」の属性が付与された頂点Ｖは、拡大演算の場合には、図１０（ａ）に示すように、頂点Ｖを挟む２つの辺（ベクトル）ＵＶおよびＶＷを、変更幅（垂直距離）ｄだけ、外部に平行移動させて、ベクトルＵ’Ｖ’およびＶ’Ｗ’とし、それらのベクトルＵ’

V’およびV” W’の延長線の交点V”’を頂点Vに対する仮図形の頂点とする。縮小演算の場合には、図１０（ｂ）に示すように、頂点Vを挟む２辺UVおよびVWを、変更幅（垂直距離）ｄだけ、内部に平行移動させて、ベクトルU’ V’およびV” W’とし、それらの交点V”’を頂点Vに対する仮図形の頂点とする。

【００７３】これに対して、登録された頂角Vの種別が、Ｔ４またはＴ６のいずれかになっている場合には、拡大演算の場合における内角θが凹角（πより大）、あるいは縮小演算の場合における外角θが凸角（πより小）になっており、さらに、その頂点Vが斜辺の影響を受けるかどうかを、頂点Vに隣接する各頂点UおよびWをそれぞれ挟む各一対の辺のいずれかが斜辺であるかどうかによって判定する（ステップ８－２）。そして、頂点UおよびWをそれぞれ挟む各一対の辺がそれぞれ斜辺でない場合には、頂点Vは斜辺の影響を受けないものとして、「Ｐ－Ａ」の属性が付与され（ステップ８－３）、頂点Vは、プロセスＡによって仮図形の頂点が生成される。

【００７４】このようにして「Ｐ－Ａ」の属性が付与された頂点Vも、拡大演算の場合には、図１０（ａ）に示すように、また、縮小演算の場合には、図１０（ｂ）に示すように、頂点Vを挟む２辺UVおよびVWを、変更幅（垂直距離）ｄだけ、外部または内部に平行移動させて、ベクトルU’ V’およびV” W’とし、それらの交点V”’または各ベクトルU’ V’およびV” W’の延長線の交点V”’を頂点Vに対する仮図形の頂点とする。

【００７５】このようにして、ＯＲ演算図形Ｆの頂点Vの属性が付与されると、図１におけるフローチャートのステップ１－１８に示すように、頂点Vの属性が判定され、頂点Vの属性が「Ｐ－Ａ」の場合には、図５に示すフローチャートに基づくプロセスＡによって、頂点Vに対応する仮図形の頂点V”’が生成される（ステップ１－１９）。

【００７６】これに対して、ＯＲ演算図形Ｆの頂点Vの属性が「Ｐ－Ｂ」の場合には、プロセスＡとは異なり、斜辺の影響を受けるものとして、プロセスＢによって、頂点Vに対する仮図形の３つの頂点が生成される（ステップ１－２０）。

【００７７】図１１は、ＯＲ演算図形Ｆの頂点Vに対する仮図形の頂点を、プロセスＢによって生成する方法を示すフローチャート、図１２はそのプロセスＢによる仮図形の頂点の生成方法の説明図である。プロセスＢでは、拡大演算する場合には、図１２（ａ）に示すように、頂点Vを挟む２辺UVおよびVWを、変更幅（垂直距離）ｄだけ、ＯＲ演算図形Ｆの外部に平行移動して、それぞれベクトルU’ V’とベクトルV” W’とする（図１１のステップ１１－１）。縮小演算する場合には、図１２（ｂ）に示すように、頂点Vを挟む２辺UVおよびVWを、それぞれ、変更幅（垂直距離）ｄだけ、

図形の内部に平行移動して、ベクトルU’ V’およびベクトルV” W’とする。図形の全ての辺は、図形の内部が右側になるようにベクトル化されているために、図形の外部方向および内部方向は容易に識別することができる。

【００７８】このようにして、頂点Vに対して２つの端点V’およびV”が得られるが、これらの端点V’およびV”が、仮図形の頂点としてそれぞれ登録される。この場合、ＯＲ演算図形Ｆの頂点Vも仮図形の頂点として登録される。仮図形の３つの頂点V、V’、V”は次のように順番に登録される。すなわち、仮図形の頂点の生成が、ＯＲ演算図形におけるベクトル化された各辺のベクトルの方向に沿って順番に実施されているために、頂点Ｕ－Ｖ－Ｗの順に処理され、頂点Ｕが、頂点Ｖの処理に先立って処理されるとともに、頂点Ｗが、頂点Ｖの処理後に処理されるようになっている。このために、辺ＵＶを平行移動した際の頂点Ｖに対応する端点Ｖ’は、頂点Ｕに対応する端点Ｕ’と頂点Ｖとの間に登録される。辺ＶＷを平行移動した際の頂点Ｖに対応する端点Ｖ”は、頂点Ｗに対応する端点Ｗ’と頂点Ｖとの間に登録される。従って、仮図形の頂点列としては、頂点Ｕ’の次に頂点Ｖ’が登録され（ステップ１１－２）、次に頂点Ｖが登録され（ステップ１１－３）、さらにその後に頂点Ｖ”が登録される（ステップ１１－４）。従って、仮図形の頂点としては、Ｕ’－Ｖ’－Ｖ－Ｖ”－Ｗ’の順に登録される。

【００７９】このような仮図形の頂点列の登録は、入力図形群ＳをＯＲ演算した際に得られるＯＲ演算図形Ｆが複数の場合には、各ＯＲ演算図形Ｆ毎に仮図形が得られるように、それぞれのＯＲ演算図形Ｆに対して仮図形の頂点列が生成される（図１（ｂ）のステップ１－２２）。そして、全ての仮図形の頂点列を設定登録された順に結ぶことにより、仮図形が生成される（ステップ１－２３）。ＯＲ演算図形Ｆの数がＮ個の場合には、生成される仮図形もＮ個になる。

【００８０】全ての仮図形が生成されると、全仮図形に対してＯＲ演算される（ステップ１－２４）。そして、ＯＲ演算されて得られた図形群が、リサイジング図形のデーターＳとして出力される（ステップ１－２５）。

【００８１】ＯＲ演算は、辺が交差も含むＮ個の仮図形に対して、総頂点数をｎとすると、Ｏ（ｎｌｏｇｎ）の計算速度で実施される。

【００８２】図２（ｃ）に示すＯＲ演算図形Ｆに対しては、全ての頂点に対して、図１のフローチャートに基づいて仮図形の頂点が登録されると、図１３（ａ）に示す１つの仮図形２１が生成される。この場合、ＯＲ演算図形Ｆの頂点数は１８であったが、仮図形２１の頂点数は２８になる。そして、図１３（ａ）に示す仮図形２１をＯＲ演算することにより、図１３（ｂ）に示すリサイジング（拡大）図形２２が得られ、この図形が出力される

ことになる。

【００８３】本実施例では、頂点Ｖが斜辺に影響されるかどうかの属性を判定することにより、頂点Ｖに対応する仮図形の頂点を１つだけ生成するプロセスＡを実施すべき「Ｐ－Ａ」と、対応する仮図形の頂点を３つ生成するプロセスＢを実施すべき「Ｐ－Ｂ」とに分類されるが、この属性の分類の条件判定は、各頂点毎に実施されるだけであり、その後に実施されるＯＲ演算に要する計算時間に比して高速で処理することができる。

【００８４】しかも、斜辺を含まない図形に対しては、その頂点のいずれもが、１つの頂点に対して仮図形の頂点が１つしか生成されない「Ｐ－Ａ」の属性に分類されるために、仮図形の総頂点数が削減されて、その後のＯＲ演算処理も高速で実施することができる。

【００８５】なお、上記実施例では、ＯＲ演算図形Ｆが斜辺を有している場合において、頂点Ｖの角度θがπよりも大きいときには（頂点の角度の種別がＴ４～Ｔ６）、頂点の属性の判定、すなわち、頂点Ｖが斜辺の影響を受けるかどうかの判定を、図８に示すように、頂点Ｖに隣接する各頂点ＵおよびＷを、それぞれ挟む一対の辺のいずれかが斜辺であるかどうかによって実施するようにしたが、例えば、その頂点Ｖに隣接する頂点ＵおよびＷの角度（頂点ＵおよびＷの種別Ｔ１～Ｔ６）に基づいて、頂点Ｖの属性を判断するようにしてもよい。

【００８６】図１４は、その場合のフローチャートを示している。この場合には、頂点Ｖの属性を調べる際に、頂点Ｖの種別がＴ１～Ｔ３のいずれかであるか、Ｔ４～Ｔ６のいずれかであるかを調べ（ステップ１４－１）、頂点Ｖの種別がＴ１～Ｔ３の場合（頂点の角度$\theta<\pi$）には、図８に示す例と同様に、頂点Ｖは、斜辺の影響を受けないものとして、プロセスＡにより処理すべきである「Ｐ－Ａ」の属性とされる（ステップ１４－４）。すなわち、拡大演算の場合における頂点Ｖの内角θがπよりも小さな凸角、または、縮小演算の場合における頂点Ｖの外角θがπよりも大きな凹角であれば、「Ｐ－Ａ」の属性とされて、頂点Ｖに対して、仮図形の１つの頂点が生成される。

【００８７】これに対して、頂点Ｖの種別がＴ４～Ｔ６の場合（頂点Ｖの角度$\theta>\pi$）には、頂点Ｖに隣接する頂点ＵおよびＷの種別がＴ１～Ｔ３であるか、Ｔ４～Ｔ６であるかをそれぞれ調べる（ステップ１４－２および１４－３）。そして、頂点Ｖに隣接する頂点ＵおよびＷのいずれもが、種別Ｔ１～Ｔ３になっている場合、すなわち、頂点ＵおよびＷの角度が、いずれもπよりも小さい場合にのみ、頂点Ｖは、斜辺に影響されるものとして、プロセスＢにより処理すべき「Ｐ－Ｂ」の属性が付与される（ステップ１４－５）。頂点Ｖに隣接する頂点ＵおよびＷのいずれかの種別がＴ４～Ｔ６の場合、すなわち、頂点ＵおよびＷの角度θがπよりも大きい場合には、頂点Ｖは、斜辺の影響を受けないものとして、プロセスＡによって処理すべき「Ｐ－Ａ」の属性が付与される（ステップ１４－４）。

【００８８】本実施例の場合には、図２（ｃ）に示すＯＲ演算図形Ｆに対して、図１５に示すリサイジング（拡大）仮図形２３が生成される。この場合には、仮図形２３の頂点数は３０になる。そして、この仮図形２３をＯＲ演算することにより、図１３（ｂ）に示すリサイジング（拡大）図形２２が得られる。

【００８９】図１６は、頂点Ｖの属性を調べる方法のさらに他の実施例を示すフローチャートである。本実施例では、頂点Ｖが斜辺の影響を受けるかどうかの属性を、頂点Ｖの角度θと、頂点Ｖに隣接する各頂点ＵおよびＷの角度と、さらに、頂点Ｖと隣接する各頂点ＵおよびＷの角度それぞれとの和とに基づいて判定するようになっている。

【００９０】すなわち、頂点Ｖの角度の種別がＴ１～Ｔ３の場合（頂点の角度$\theta<\pi$）には（ステップ１６－１）、頂点Ｖは斜辺の影響を受けないものとして、前記各実施例と同様に、斜辺の影響を受けないものとして、「Ｐ－Ａ」の属性とされる（ステップ１６－６）。

【００９１】これに対して、頂点Ｖの角度θの種別がＴ４（$\pi<\theta<3\pi/2$）の場合には、頂点Ｖに隣接する各頂点ＵおよびＷのいずれもが種別Ｔ３（$\pi/2<\theta<\pi$）でなければ（ステップ１６－２および１６－４）、頂点Ｖの斜辺の影響を受けないものとして「Ｐ－Ａ」の属性とされる（ステップ１６－６）。

【００９２】しかしながら、頂点Ｖの角度θの種別がＴ４（$\pi<\theta<3\pi/2$）であって、頂点Ｖに隣接する各頂点ＵおよびＷのいずれかが種別Ｔ３（$\pi/2<\theta<\pi$）である場合には、種別Ｔ３の頂点ＵまたはＷの角度と頂点Ｖの角度との和が2πよりも大きいときにのみ、頂点Ｖは斜辺の影響を受けるものとして、「Ｐ－Ｂ」の属性とされる（ステップ１６－７）。頂点Ｖの角度の種別がＴ４の場合には、このような条件以外では、頂点Ｖの属性は「Ｐ－Ａ」とされる。

【００９３】これにより、ＯＲ演算図形を拡大演算する場合には、頂点Ｖの内角θが、$\pi<\theta<3\pi/2$の凹角であり、しかも、隣接する頂点ＵまたはＷのいずれかの内角θ'が、$\pi/2<\theta'<\pi$の凸角であって、さらに、$(\theta+\theta')>2\pi$であるときに限り、頂点Ｖの属性として「Ｐ－Ｂ」が付与される。従って、ＯＲ演算図形に４５°または１３５°の斜辺だけが含まれている場合には、この条件を満足する頂点Ｖと頂点ＵまたはＷとの組み合わせは存在せず、この場合には、ＯＲ演算図形の各頂点は、Ｐ－Ａの属性が付与されて、各頂点に対して仮図形の頂点が１つずつ生成される。

【００９４】頂点Ｖの角度の種別がＴ５（$\theta=3\pi/2$）の場合には、図１６（ｂ）に示すように、頂点Ｖに隣接する各頂点ＵおよびＷのいずれかが種別Ｔ３（$\pi/2<\theta<\pi$）であれば（ステップ１６－８および１６－

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９）、頂点Ｖの属性は、「Ｐ－Ｂ」とされる（ステップ１６－７）。頂点Ｖの角度の種別がＴ５（$\theta=3\pi/2$）の場合では、このような条件になければ、頂点Ｖの属性は「Ｐ－Ａ」とされる（ステップ１６－６）。

【００９５】これにより、ＯＲ演算図形を拡大演算する場合には、頂点Ｖの内角θが、$\theta=3\pi/2$の凹角であり、隣接する頂点ＵまたはＷのいずれかの内角θ'が、$\pi/2<\theta'<\pi$の凸角であるときに限り、頂点Ｖは、斜辺の影響を受けるものとして、「Ｐ－Ｂ」の属性とされる。従って、ＯＲ演算図形に４５°または１３５°の斜辺だけが含まれている場合には、頂点Ｖの角度θが２７０°であって、頂点ＵまたはＷの角度θ'が１３５°の場合にのみ、その頂点Ｖは斜辺の影響をうけるものとして、プロセスＢにより、仮図形の３つの頂点が生成される。

【００９６】頂点Ｖの角度の種別がＴ６（$3\pi/2<\theta<2\pi$）の場合には、図１６（ｃ）に示すように、頂点Ｖに隣接する各頂点ＵおよびＷのいずれかが種別Ｔ２（$\theta=\pi/2$）またはＴ３（$\pi/2<\theta<\pi$）であれば（ステップ１６－１０および１６－１２）、頂点Ｖの属性は、「Ｐ－Ｂ」とされる（ステップ１６－７）。また、頂点Ｖに隣接する各頂点ＵおよびＷのいずれかが種別Ｔ１（$0<\theta<\pi/2$）であれば、種別Ｔ１の頂点ＵまたはＷの角度と頂点Ｖの角度との和が2πよりも大きいと（ステップ１６－１１および１６－１３）、頂点Ｖの属性は、「Ｐ－Ｂ」とされる（ステップ１６－７）。頂点Ｖの角度の種別がＴ６の場合（$3\pi/2<\theta<2\pi$）では、このような条件になっていないと、頂点Ｖは、斜辺の影響を受けないものとして、「Ｐ－Ａ」の属性とされる（ステップ１６－６）。

【００９７】これにより、ＯＲ演算図形を拡大演算する場合には、頂点Ｖの内角θが、$3\pi/2<\theta<2\pi$の凹角であり、しかも、隣接する頂点ＵまたはＷのいずれかの内角θ'が、$\pi/2\leqq\theta'<\pi$の凸角であるか、もしくは、$0<\theta'<\pi/2$の凸角で$(\theta+\theta')>2\pi$であるときに限り、頂点Ｖは斜辺の影響を受けるものとして「Ｐ－Ｂ」の属性が付与される。従って、ＯＲ演算図形に４５°または１３５°の斜辺だけが含まれている場合には、頂点Ｖの角度$\theta=315°$、頂点ＵまたはＷの角度$\theta'=90°$のとき、または、頂点Ｖの角度$\theta=315°$、頂点ＵまたはＷの角度$\theta'=135°$のときにのみ、斜辺の影響を受けるものとして、プロセスＢによって３つの仮図形の頂点が生成される。

【００９８】本実施例では、頂点Ｖの属性は、対応する仮図形の頂点を１つだけ生成するプロセスＡを実施すべき「Ｐ－Ａ」と、対応する仮図形の頂点を３つ生成するプロセスＢを実施すべき「Ｐ－Ｂ」とに分類されるが、この属性の分類の条件判定は、各頂点毎に実施されるだけであり、その後に実施されるＯＲ演算に要する計算時間に比して高速で処理することができる。

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【００９９】しかも、斜辺を含まない図形の場合には、その頂点のいずれもが、１つの頂点に対して仮図形の頂点が１つしか生成されない「Ｐ－Ａ」の属性に分類される。また、垂直辺および水平辺以外に、水平辺に対して４５°および１３５°の斜辺しか含まない図形に対しても、連続する２つの頂点の角度（拡大演算の場合には内角の角度、縮小演算の場合には外角の角度）θおよびθ'の組み合わせは、$\theta=270°$および$\theta'=135°$と、$\theta=315°$および$\theta'=90°$と、$\theta=315°$および$\theta'=135°$の３通りの場合に限られ、角度θとなった頂点のみが、仮図形の頂点として３つが生成されるように「Ｐ－Ｂ」に分類され、他の頂点は「Ｐ－Ａ」に分類される。

【０１００】従って、本実施例では、仮図形の頂点数が、ＯＲ演算図形の頂点に対して３つの仮図形の頂点が生成されるプロセスＢが適用される属性「Ｐ－Ｂ」になることはごくまれである。その結果、仮図形の頂点数を著しく削減することができ、仮図形のＯＲ演算処理に要する時間を著しく短縮することが可能になる。

【０１０１】本実施例の場合には、図２（ｃ）に示すＯＲ演算図形Ｆに対して、図１７に示すリサイジング（拡大）仮図形２４が生成される。この場合には、入力図形Ｆの総頂点数１８に対して、仮図形２４の頂点数は２２になり、４つの頂点が増加しているにすぎない。そして、この仮図形２４をＯＲ演算することにより、図１３（ｂ）に示すリサイジング（拡大）図形２２が得られる。

【０１０２】従って、折れ曲がりの多い配線パターンのような複雑な図形において、斜辺が局所的に使用されているような場合には、本実施例によって、３つの仮図形の頂点を生成するプロセスＢの適用範囲を限定することができ、高速処理が可能になる。

【０１０３】

【発明の効果】本発明のマスクパターンのリサイジング方法は、このように、入力図形に対して斜辺が含まれているかどうかを判定し、さらに、斜辺が含まれている場合には、入力図形の各頂点が斜辺の影響を受けるかどうかを判定して、頂点が斜辺の影響を受ける場合にのみ、その頂点に対して３つの仮図形の頂点を生成するようにしている。従って、入力図形に斜辺が含まれていても、斜辺の影響を受けない頂点に対しては、仮図形の頂点は１つしか生成されず、仮図形の総頂点数を削減することができて、その後のＯＲ演算処理を高速化することができる。

【０１０４】頂点が斜辺の影響を受けるかどうかは、その頂点に隣接する各頂点をそれぞれ挟む各一対の辺によって判定することができるが、その頂点の角度とその頂点に隣接する各頂点の角度とに基づいて、さらに、その頂点の角度とその頂点に隣接する各頂点の角度と、隣接する頂点のいずれか一方ともとの頂点の角度との和に基

づいて判定することにより、３つの仮図形の頂点を生成するプロセスが適用される範囲が制限され、仮図形の総頂点数がより一層、削減されて、その後のＯＲ演算処理を高速化することができる。

【図面の簡単な説明】

【図１】（ａ）および（ｂ）は、それぞれ、本発明のマスクパターンのリサイジング方法の手順の一例を示すフローチャートである。

【図２】（ａ）は、ＬＳＩのマスクパターンの一例、（ｂ）はそのマスクパターンのＣＡＤシステムに入力される入力図形、（ｃ）はその入力図形をＯＲ演算して得られたＯＲ演算図形である。

【図３】ＯＲ演算図形の全ての頂点の角度の種別を判定するため方法の手順の一例を示すフローチャートである。

【図４】（ａ）～（ｆ）は、それぞれ、ＯＲ演算図形の頂点の角度の種別Ｔ１～Ｔ６の説明図である。

【図５】ＯＲ演算図形が斜辺を含んでいない場合のそのＯＲ演算図形の頂点に対する仮図形の頂点の生成方法であるプロセスＡの手順を示すフローチャートである。

【図６】（ａ）および（ｂ）は、それぞれ、プロセスＡによる仮図形の頂点の生成方法の説明図である。

【図７】ＯＲ演算図形の各辺を平行移動する際の手順の一例を示すフローチャートである。

【図８】ＯＲ演算図形の各頂点が、斜辺の影響を受けるものかどうかの属性を判定する手順の一例を示すフローチャートである。

【図９】ＯＲ演算図形における頂点が斜辺の影響を受ける場合の説明図である。

【図１０】（ａ）および（ｄ）は、それぞれ、斜辺を含むＯＲ演算図形における斜辺の影響を受けない頂点に対する仮図形の頂点の生成方法の説明図、（ｂ）および（ｃ）は、それぞれ、斜辺を含むＯＲ演算図形における斜辺の影響を受ける頂点に対する仮図形の頂点の生成方法の説明図である。

【図１１】ＯＲ演算図形の頂点に対する仮図形の頂点を、プロセスＢによって生成する方法の手順の一例を示すフローチャートである。

【図１２】（ａ）および（ｂ）は、それぞれ、そのプロセスＢによる仮図形の頂点の生成方法の説明図である。

【図１３】（ａ）は、図２（ｃ）に示すＯＲ演算図形を図１のフローチャートに基づいて生成された仮図形、（ｂ）はその仮図形をＯＲ演算して得られる拡大演算図形である。

【図１４】ＯＲ演算図形の各頂点が、斜辺の影響を受けるものかどうかの属性を判定する手順の他の例を示すフローチャートである。

【図１５】図２（ｃ）に示すＯＲ演算図形に基づいて生成された仮図形である。

【図１６】（ａ）～（ｃ）は、それぞれ、ＯＲ演算図形

の各頂点が、斜辺の影響を受けるものかどうかの属性を判定する手順の、さらに他の例を示すフローチャートである。

【図１７】図２（ｃ）に示すＯＲ演算図形に基づいて生成された仮図形である。

【図１８】（ａ）はマスクパターンの入力図形の一例、（ｂ）はその拡大図形、（ｃ）はその相似図形である。

【図１９】（ａ）～（ｇ）は、それぞれ、入力図形の拡大演算処理または縮小演算処理の説明図である。

【図２０】（ａ）は、マスクパターンの最小間隔を検証する際の入力図形の一例、（ｂ）は、その入力図形の拡大図形、（ｃ）は、最小間隔を満足していない部分の説明図である。

【図２１】（ａ）は、マスクパターンの最小幅を検証する際の入力図形の一例、（ｂ）は、その入力図形の縮小図形、（ｃ）は、最小幅を満足していない部分の説明図である。

【図２２】（ａ）は、配線可能領域を抽出する際の入力図形の一例、（ｂ）は、その入力図形の拡大図形、（ｃ）は、配線可能領域を満足する部分の説明図である。

【図２３】（ａ）は、ノッチを除去する際の入力図形の一例、（ｂ）は、その入力図形の拡大図形、（ｃ）は、その拡大図形の縮小図形である。

【図２４】（ａ）および（ｂ）は、それぞれ、ＯＲ演算の説明図である。

【図２５】（ａ）および（ｂ）は、それぞれ、従来法２によっては正確な拡大図形が得られない入力図形である。

【図２６】（ａ）および（ｂ）は、それぞれ、従来法３の手順を示すフローチャートである。

【図２７】（ａ）～（ｃ）は、それぞれ、ＯＲ演算が必要であることの説明図である。

【図２８】（ａ）はマスクパターンの入力図形の一例、（ｂ）は従来法３によりその入力図形の拡大演算における仮図形である。

【図２９】従来法４の手順を示すフローチャートである。

【図３０】（ａ）および（ｂ）は、それぞれ、従来法４によって生成された誤った拡大図形である。

【符号の説明】

１０　マスクパターン
１１　斜辺部
１２　水平部
１３　矩形部
１４　垂直部
１５　水平部
１６　矩形部
１１’　傾斜入力図形
１２’　水平入力図形

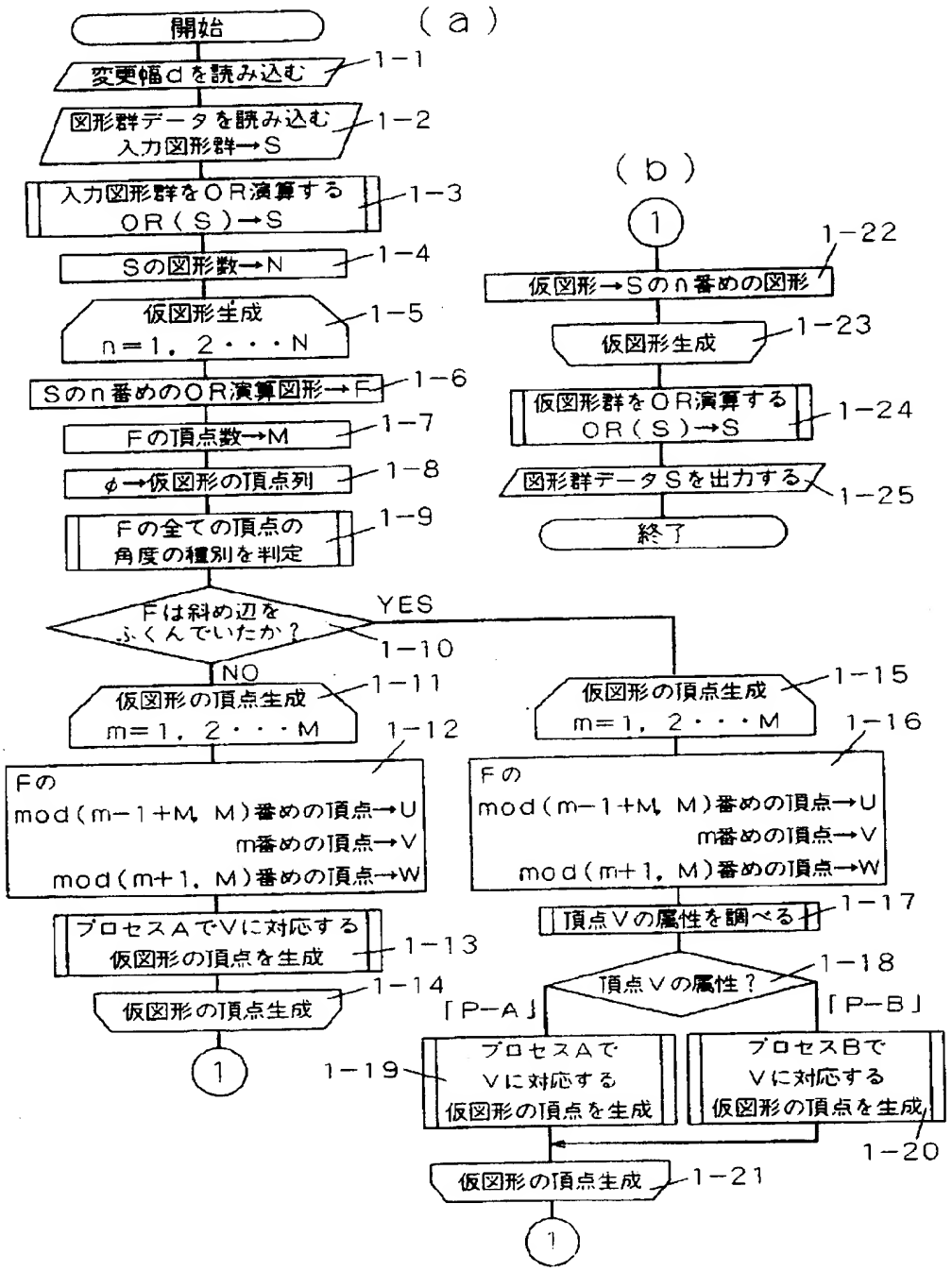
23

１３’　矩形入力図形
１４’　垂直入力図形
１５’　水平入力図形

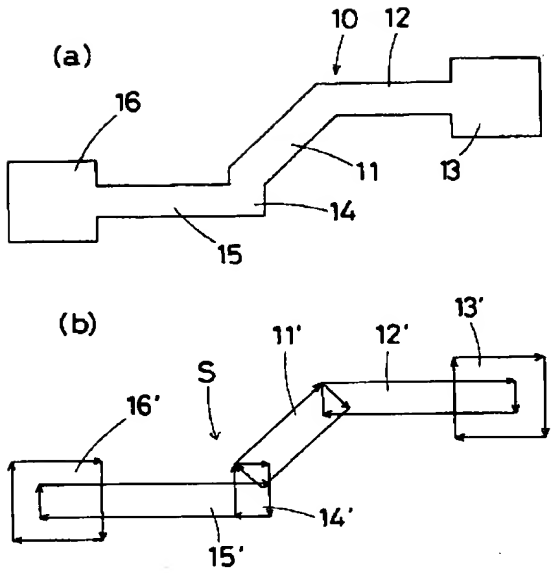
24

１６’　矩形入力図形
Ｆ　ＯＲ演算図形

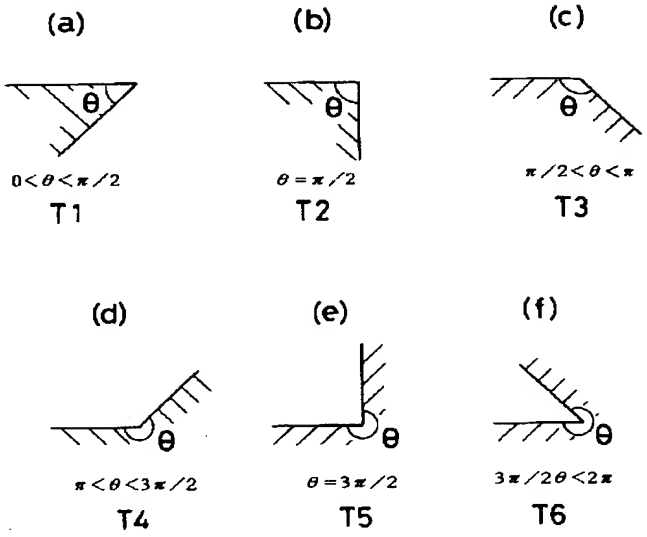
【図１】



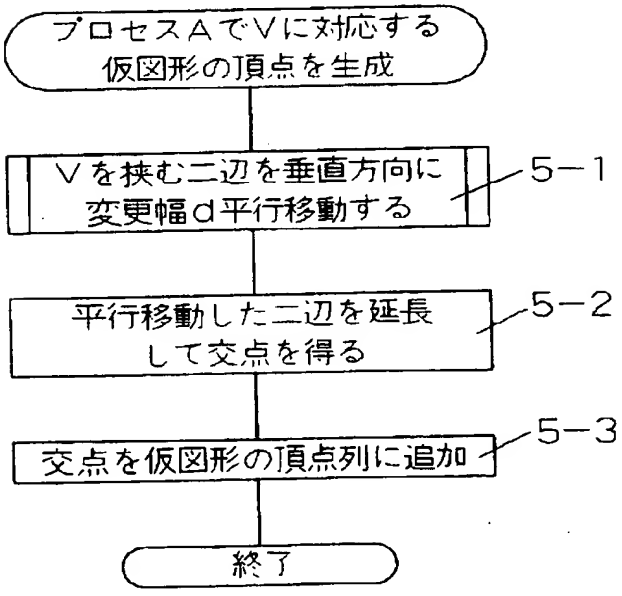
【図２】


(a)
10
12
16
11
13
14
15
(b)
11'
12'
13'
S
16'
14'
15'
(c)
F

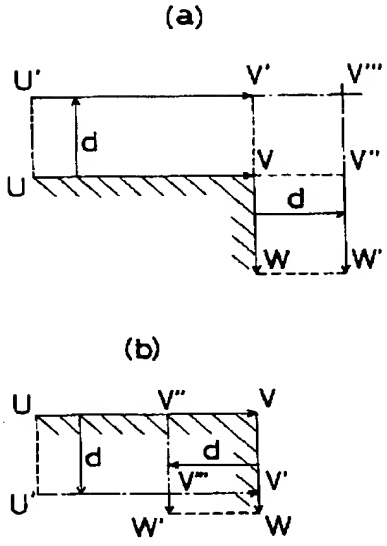
【図４】


(a)
θ
0<θ<π/2
T1
(b)
θ
θ=π/2
T2
(c)
θ
π/2<θ<π
T3
(d)
θ
π<θ<3π/2
T4
(e)
θ
θ=3π/2
T5
(f)
θ
3π/2θ<2π
T6

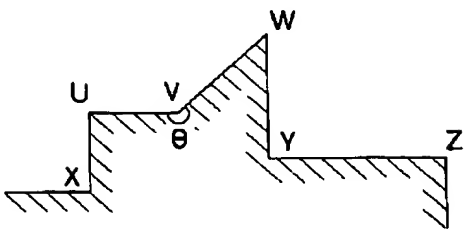
【図５】


プロセスAでVに対応する仮図形の頂点を生成
Vを挟む二辺を垂直方向に変更幅d平行移動する
5－1
平行移動した二辺を延長して交点を得る
5－2
交点を仮図形の頂点列に追加
5－3
終了

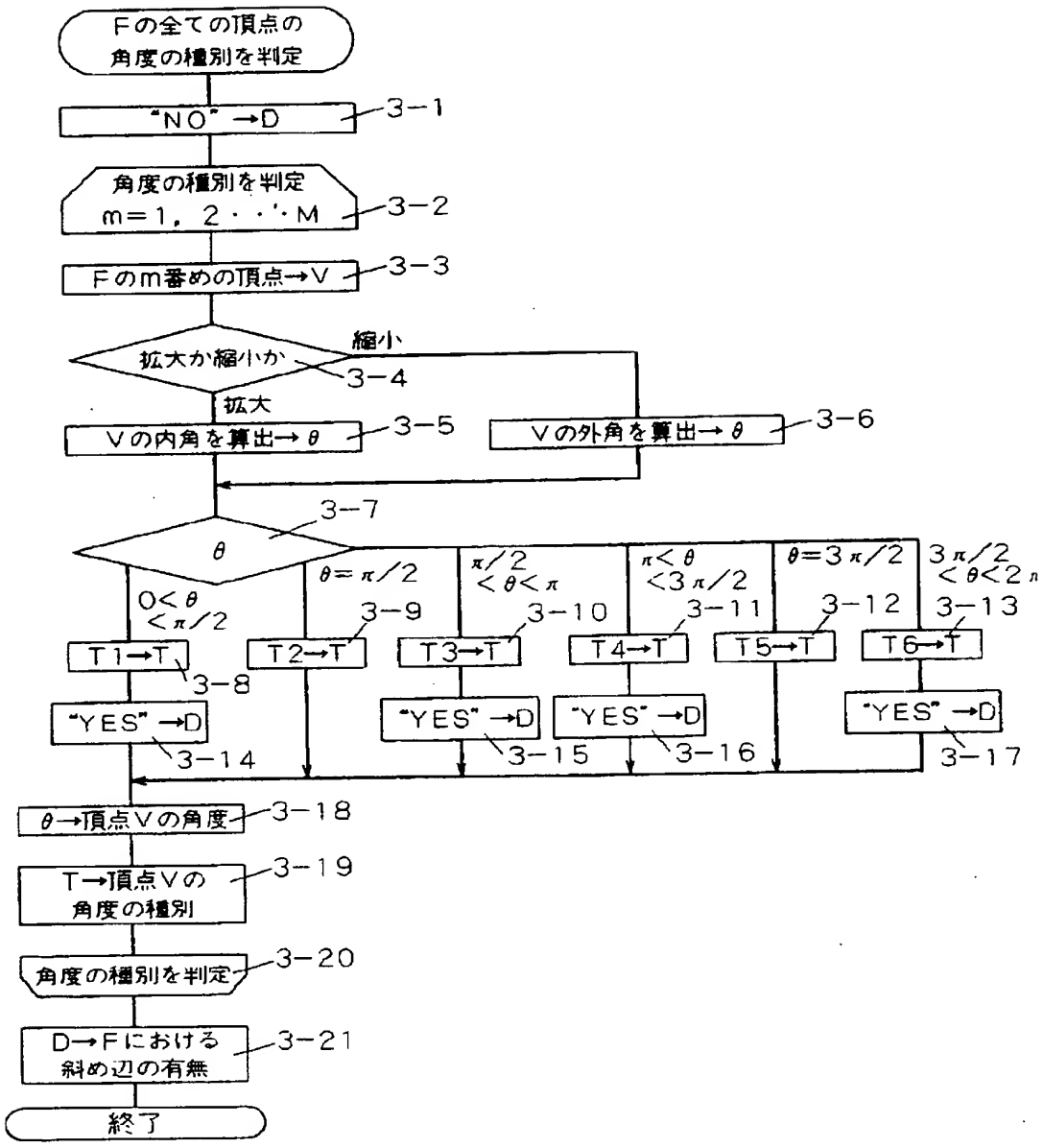
【図６】


(a)
U'
V'
V'''
d
V
V''
U
d
W
W'
(b)
U
V''
V
d
d
V'''
V'
U'
W'
W

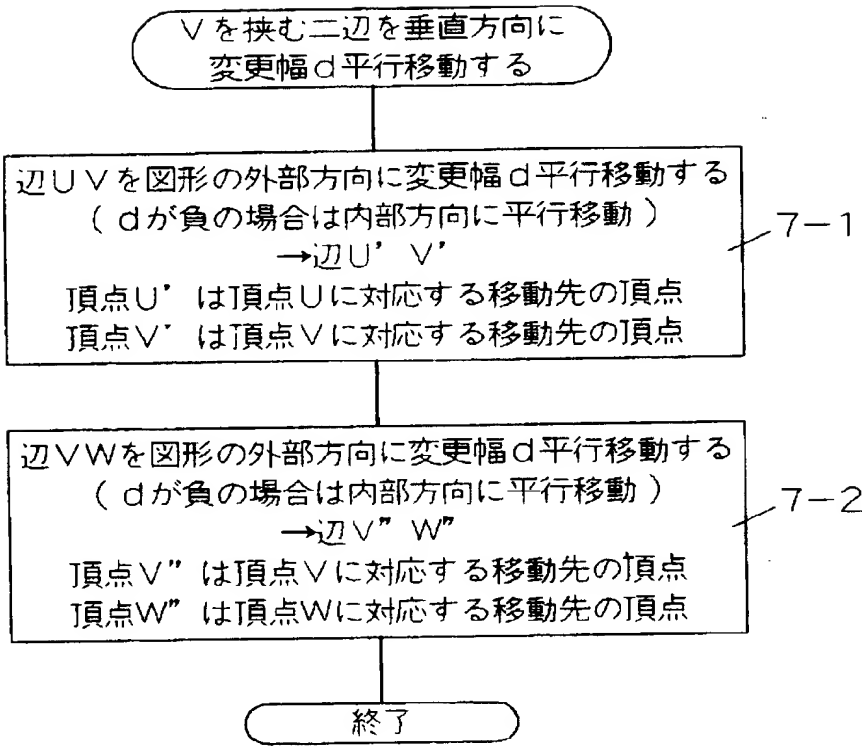
【図９】


W
U
V
θ
Y
Z
X

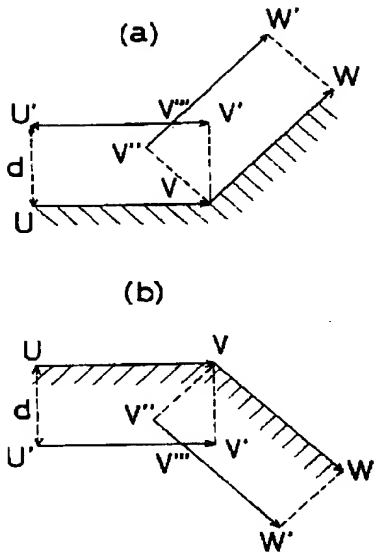
【図３】


Fの全ての頂点の角度の種別を判定
"NO" →D
3-1
角度の種別を判定 m=1, 2・・・M
3-2
Fのm番めの頂点→V
3-3
拡大か縮小か
縮小
3-4
拡大
Vの内角を算出→θ
3-5
Vの外角を算出→θ
3-6
θ
3-7
0<θ<π/2
θ=π/2
π/2<θ<π
π<θ<3π/2
θ=3π/2
3π/2<θ<2π
T1→T
3-8
T2→T
3-9
T3→T
3-10
T4→T
3-11
T5→T
3-12
T6→T
3-13
"YES" →D
3-14
"YES" →D
3-15
"YES" →D
3-16
"YES" →D
3-17
θ→頂点Vの角度
3-18
T→頂点Vの角度の種別
3-19
角度の種別を判定
3-20
D→Fにおける斜め辺の有無
3-21
終了

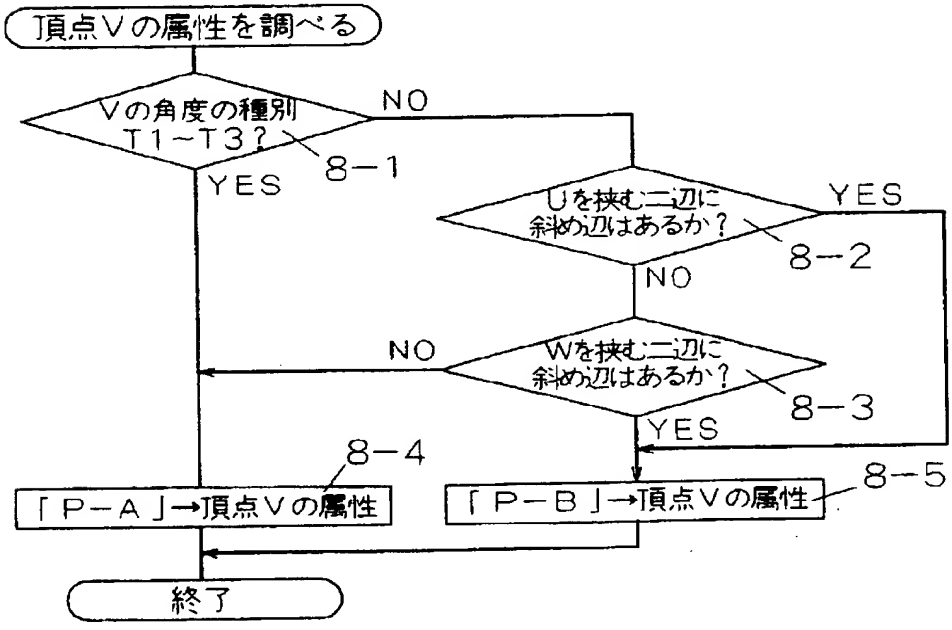
【図７】


Ｖを挟む二辺を垂直方向に
変更幅ｄ平行移動する
辺ＵＶを図形の外部方向に変更幅ｄ平行移動する
（ｄが負の場合は内部方向に平行移動）
→辺Ｕ’Ｖ’
頂点Ｕ’は頂点Ｕに対応する移動先の頂点
頂点Ｖ’は頂点Ｖに対応する移動先の頂点
7－1
辺ＶＷを図形の外部方向に変更幅ｄ平行移動する
（ｄが負の場合は内部方向に平行移動）
→辺Ｖ”Ｗ”
頂点Ｖ”は頂点Ｖに対応する移動先の頂点
頂点Ｗ”は頂点Ｗに対応する移動先の頂点
7－2
終了

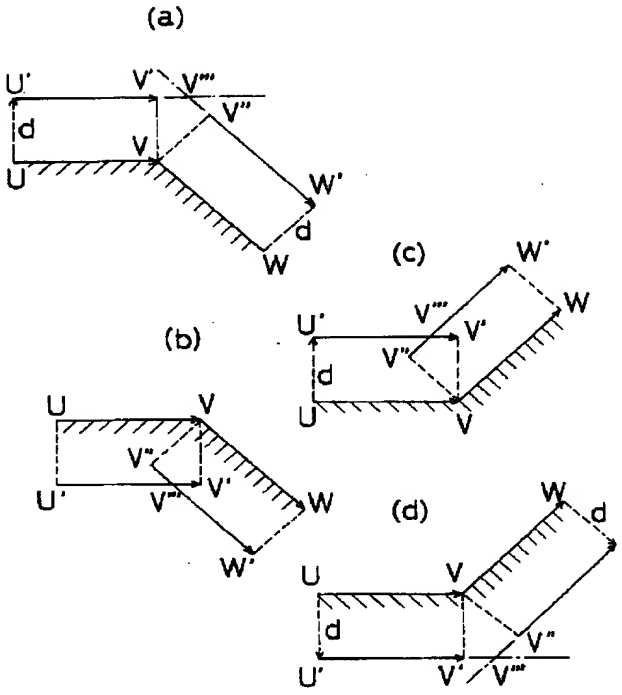
【図１２】


(a)
W'
W
U'
V'''
V'
V''
d
V
U
(b)
U
V
d
V''
U'
V'
V'''
W
W'

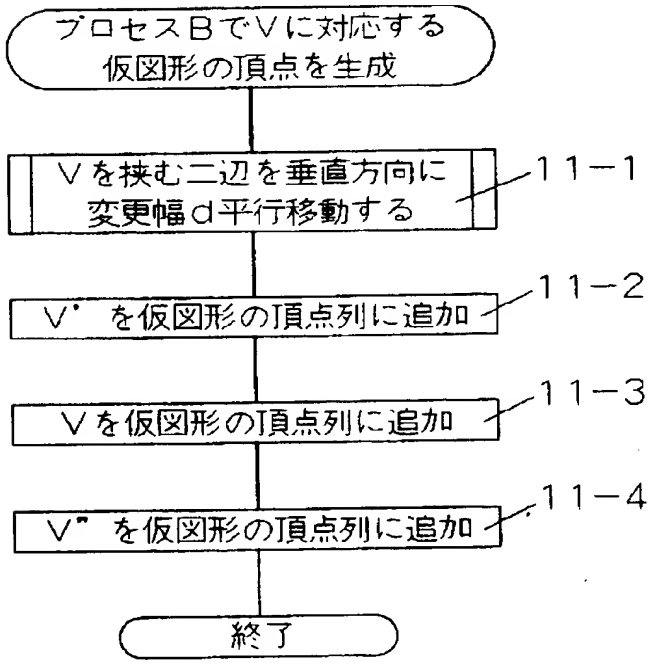
【図８】


頂点Ｖの属性を調べる
Ｖの角度の種別
Ｔ１～Ｔ３？
8－1
NO
YES
Ｕを挟む二辺に
斜め辺はあるか？
8－2
YES
NO
Ｗを挟む二辺に
斜め辺はあるか？
8－3
NO
YES
8－4
「Ｐ－Ａ」→頂点Ｖの属性
「Ｐ－Ｂ」→頂点Ｖの属性
8－5
終了

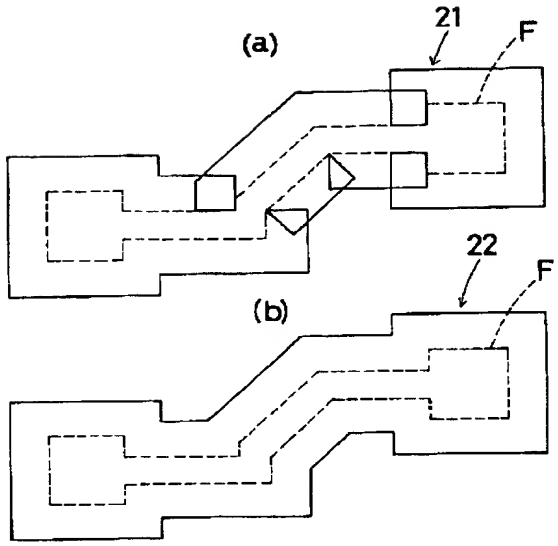
【図１０】



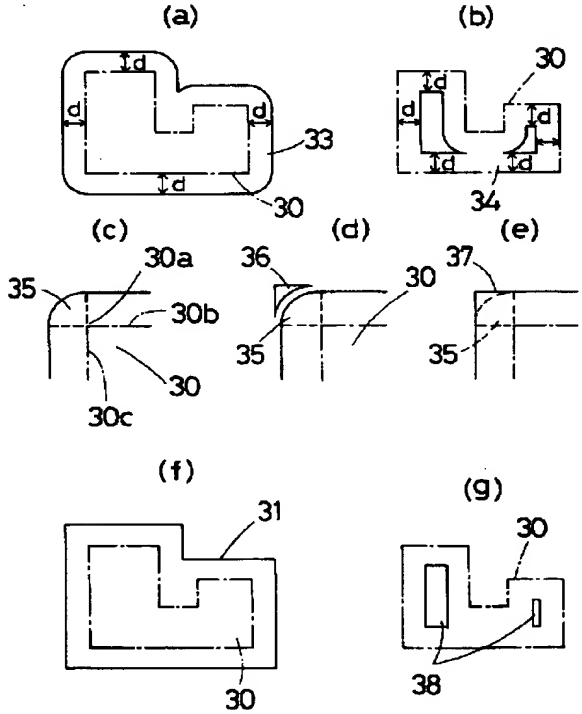
【図１１】



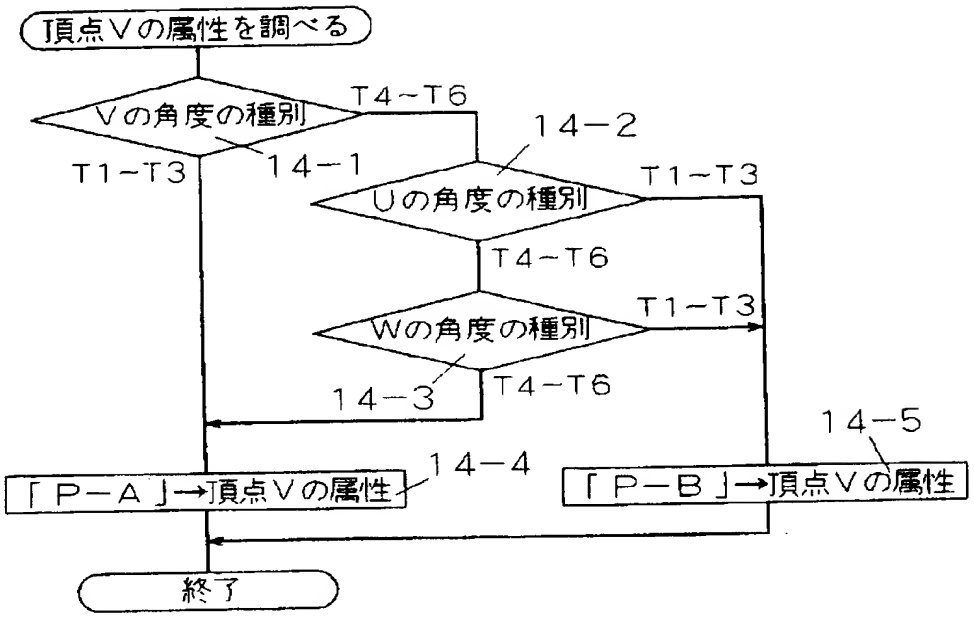
【図１３】



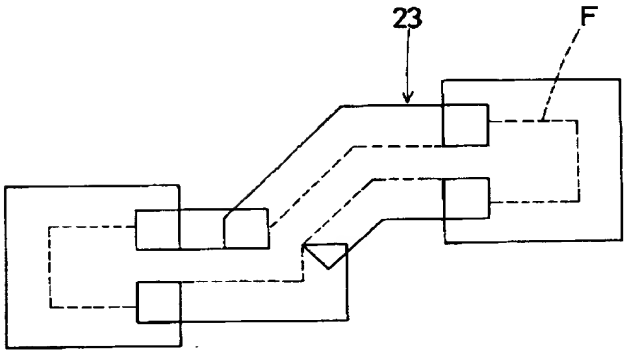
【図１９】



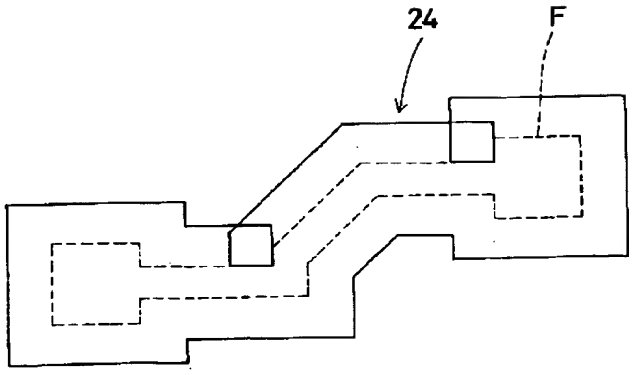
【図１４】


頂点Ｖの属性を調べる
Ｖの角度の種別
T4～T6
14－2
T1～T3
14－1
Ｕの角度の種別
T1～T3
T4～T6
Ｗの角度の種別
T1～T3
14－3
T4～T6
14－5
14－4
「Ｐ－Ａ」→頂点Ｖの属性
「Ｐ－Ｂ」→頂点Ｖの属性
終了

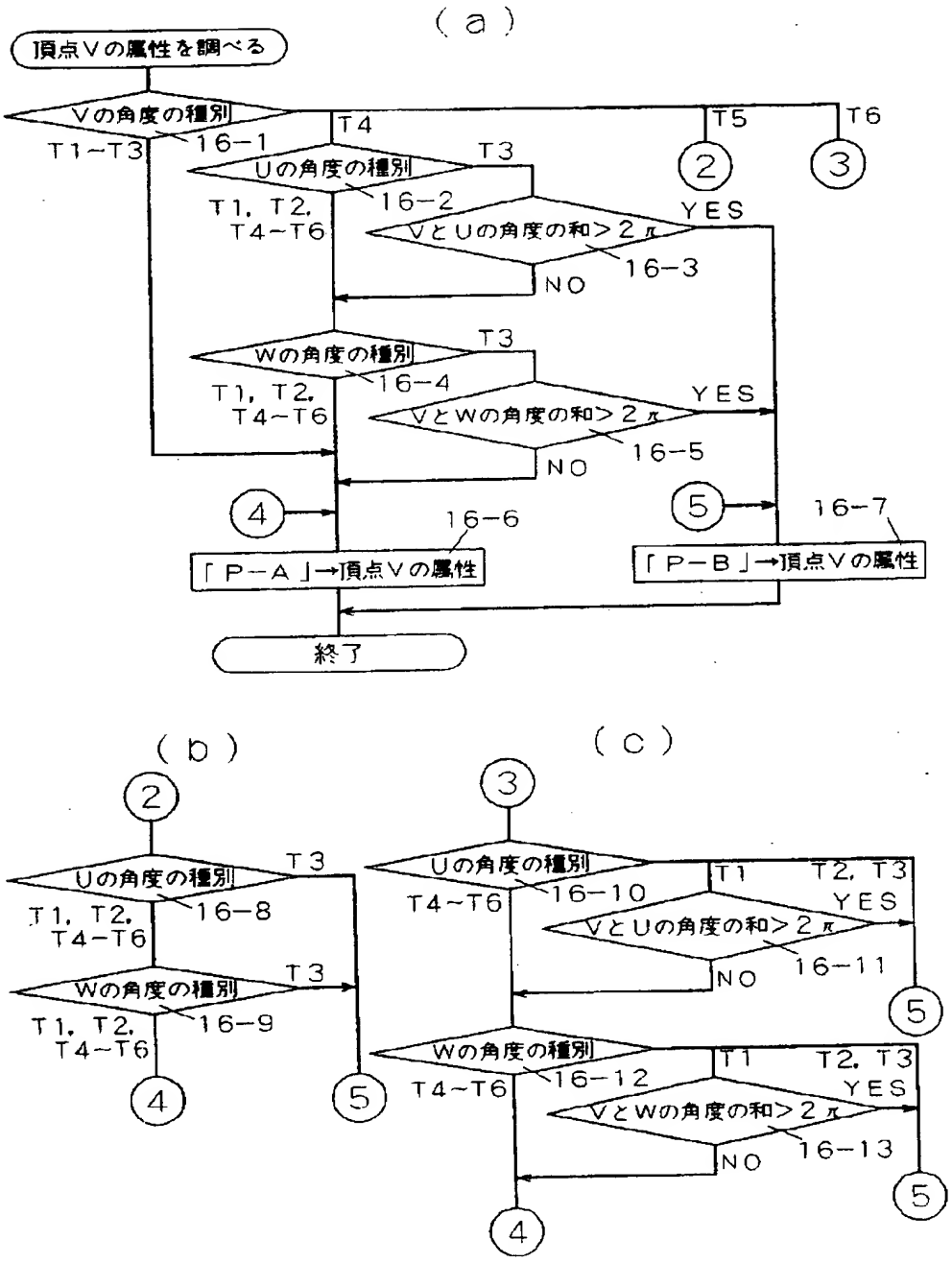
【図１５】


23
F

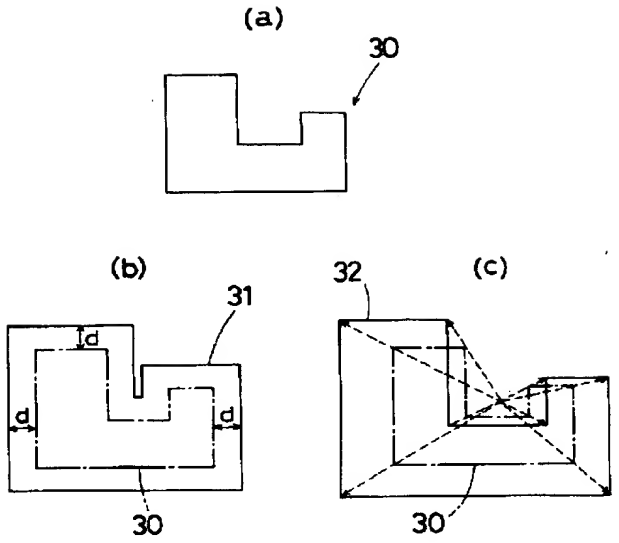
【図１７】


24
F

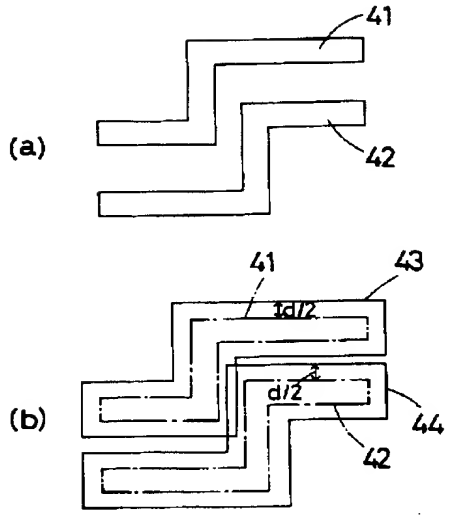
【図１６】


(a)
頂点Vの属性を調べる
Vの角度の種別
T1～T3
16-1
T4
T5
T6
Uの角度の種別
T3
T1, T2, T4～T6
16-2
2
3
YES
VとUの角度の和＞2π
16-3
NO
Wの角度の種別
T3
T1, T2, T4～T6
16-4
YES
VとWの角度の和＞2π
16-5
NO
4
5
16-6
16-7
「P－A」→頂点Vの属性
「P－B」→頂点Vの属性
終了
(b)
2
Uの角度の種別
T3
T1, T2, T4～T6
16-8
Wの角度の種別
T3
T1, T2, T4～T6
16-9
4
5
(c)
3
Uの角度の種別
T1
T2, T3
T4～T6
16-10
YES
VとUの角度の和＞2π
NO
16-11
5
Wの角度の種別
T1
T2, T3
T4～T6
16-12
YES
VとWの角度の和＞2π
NO
16-13
5
4

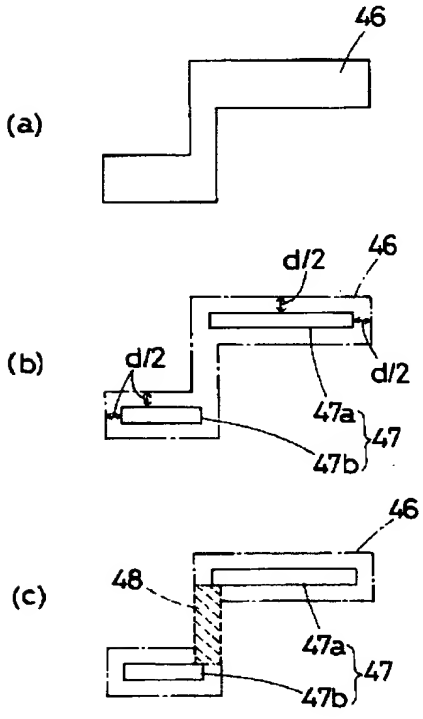
【図１８】



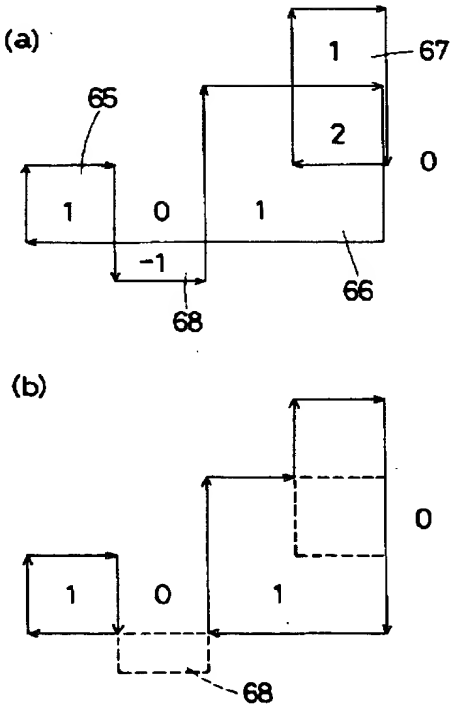
【図２０】



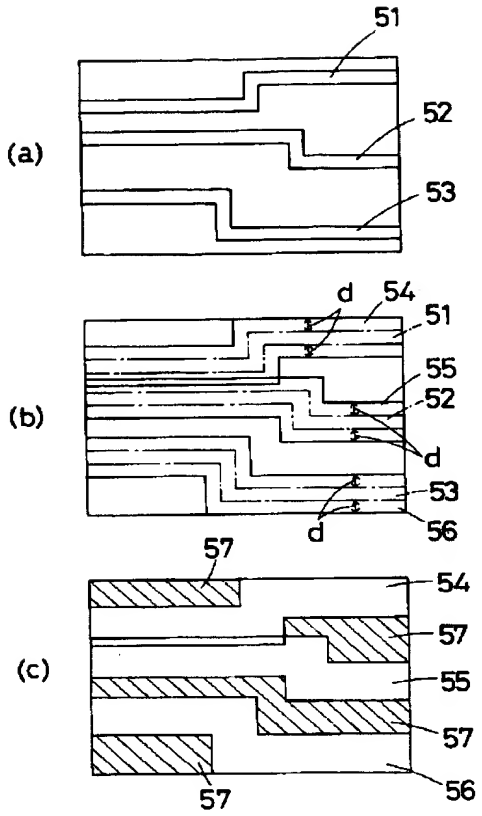
【図２１】



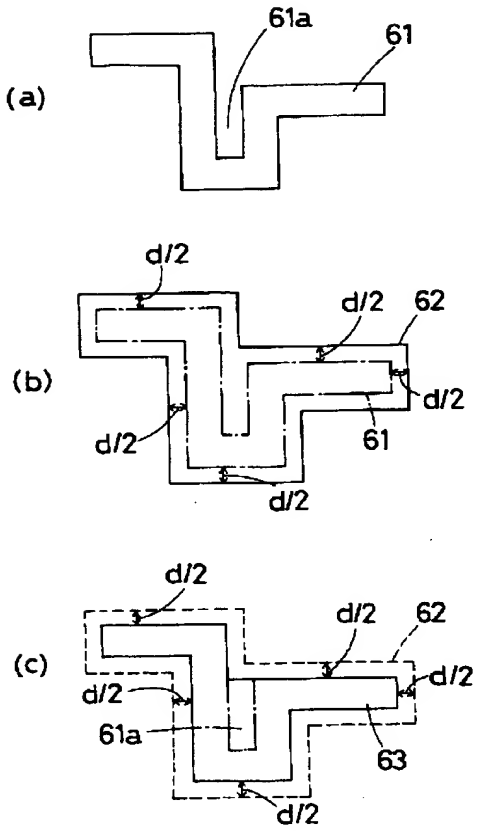
【図２４】



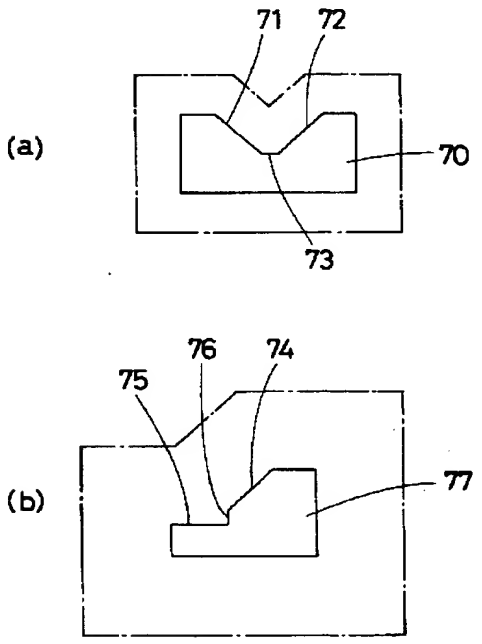
【図２２】



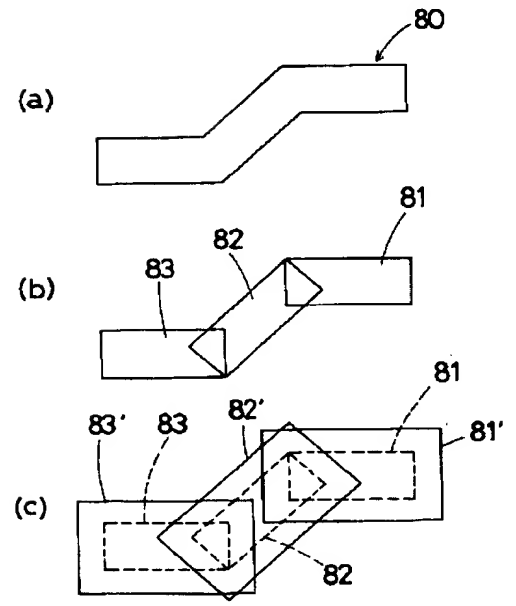
【図２３】



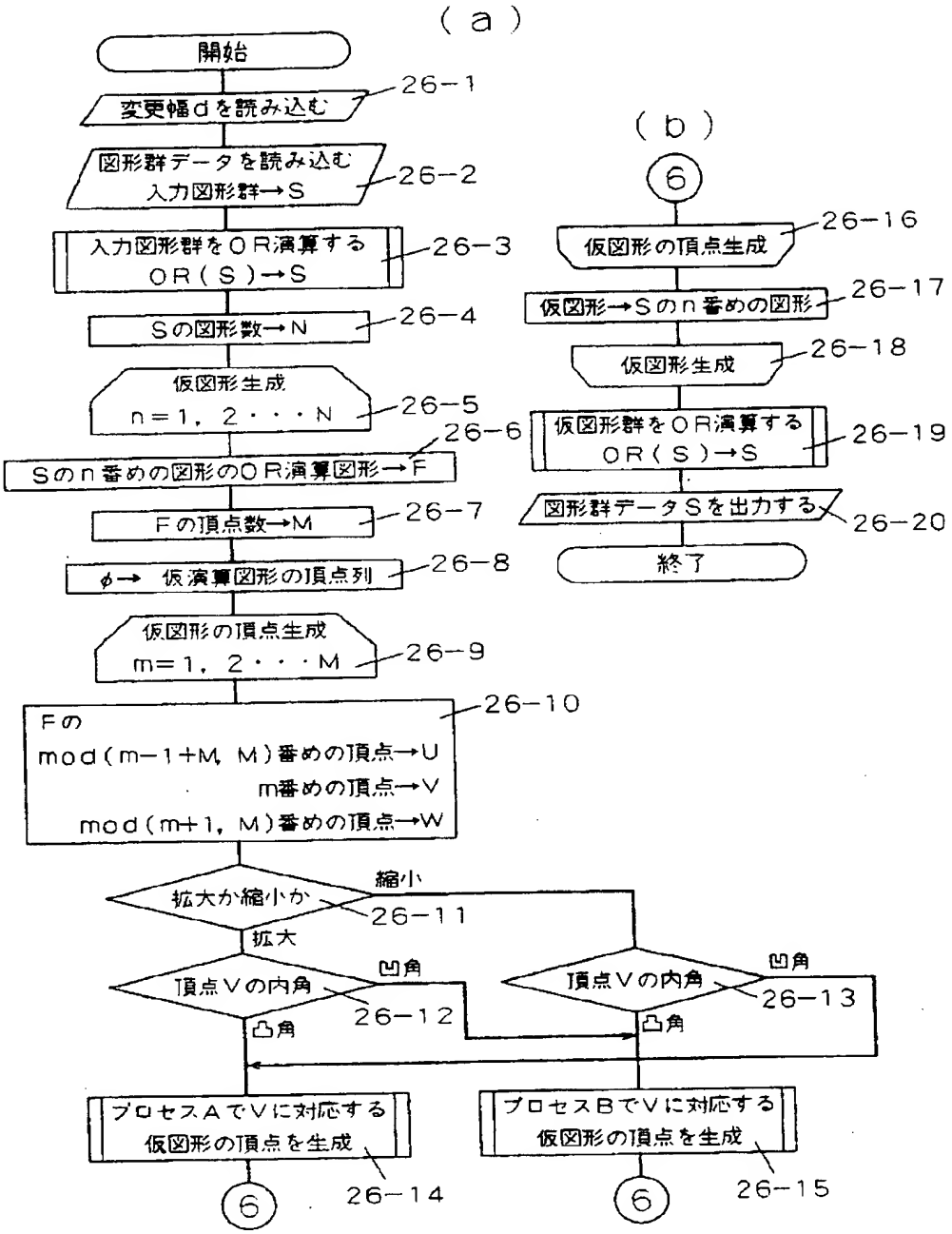
【図２５】



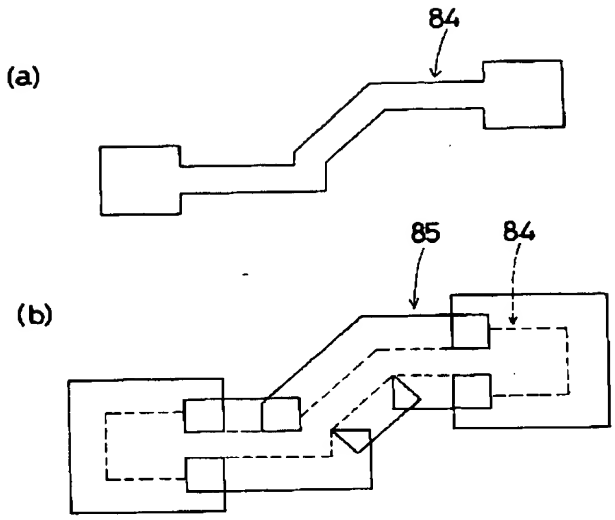
【図２７】



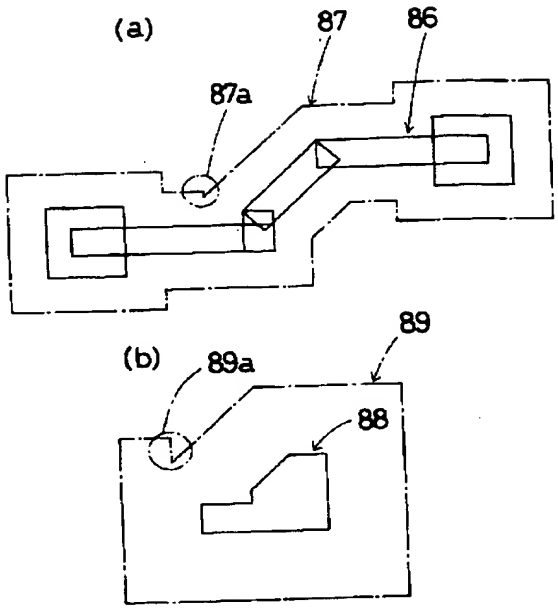
【図２６】


（ａ）
開始
変更幅ｄを読み込む
26-1
図形群データを読み込む
入力図形群→Ｓ
26-2
入力図形群をＯＲ演算する
ＯＲ（Ｓ）→Ｓ
26-3
Ｓの図形数→Ｎ
26-4
仮図形生成
ｎ＝１，２・・・Ｎ
26-5
Ｓのｎ番めの図形のＯＲ演算図形→Ｆ
26-6
Ｆの頂点数→Ｍ
26-7
φ→ 仮演算図形の頂点列
26-8
仮図形の頂点生成
ｍ＝１，２・・・Ｍ
26-9
Ｆの
ｍｏｄ（ｍ－１＋Ｍ，Ｍ）番めの頂点→Ｕ
ｍ番めの頂点→Ｖ
ｍｏｄ（ｍ＋１，Ｍ）番めの頂点→Ｗ
26-10
拡大か縮小か
縮小
拡大
26-11
頂点Ｖの内角
凹角
凸角
26-12
頂点Ｖの内角
凹角
凸角
26-13
プロセスＡでＶに対応する
仮図形の頂点を生成
26-14
プロセスＢでＶに対応する
仮図形の頂点を生成
26-15
⑥
⑥
（ｂ）
⑥
仮図形の頂点生成
26-16
仮図形→Ｓのｎ番めの図形
26-17
仮図形生成
26-18
仮図形群をＯＲ演算する
ＯＲ（Ｓ）→Ｓ
26-19
図形群データＳを出力する
26-20
終了

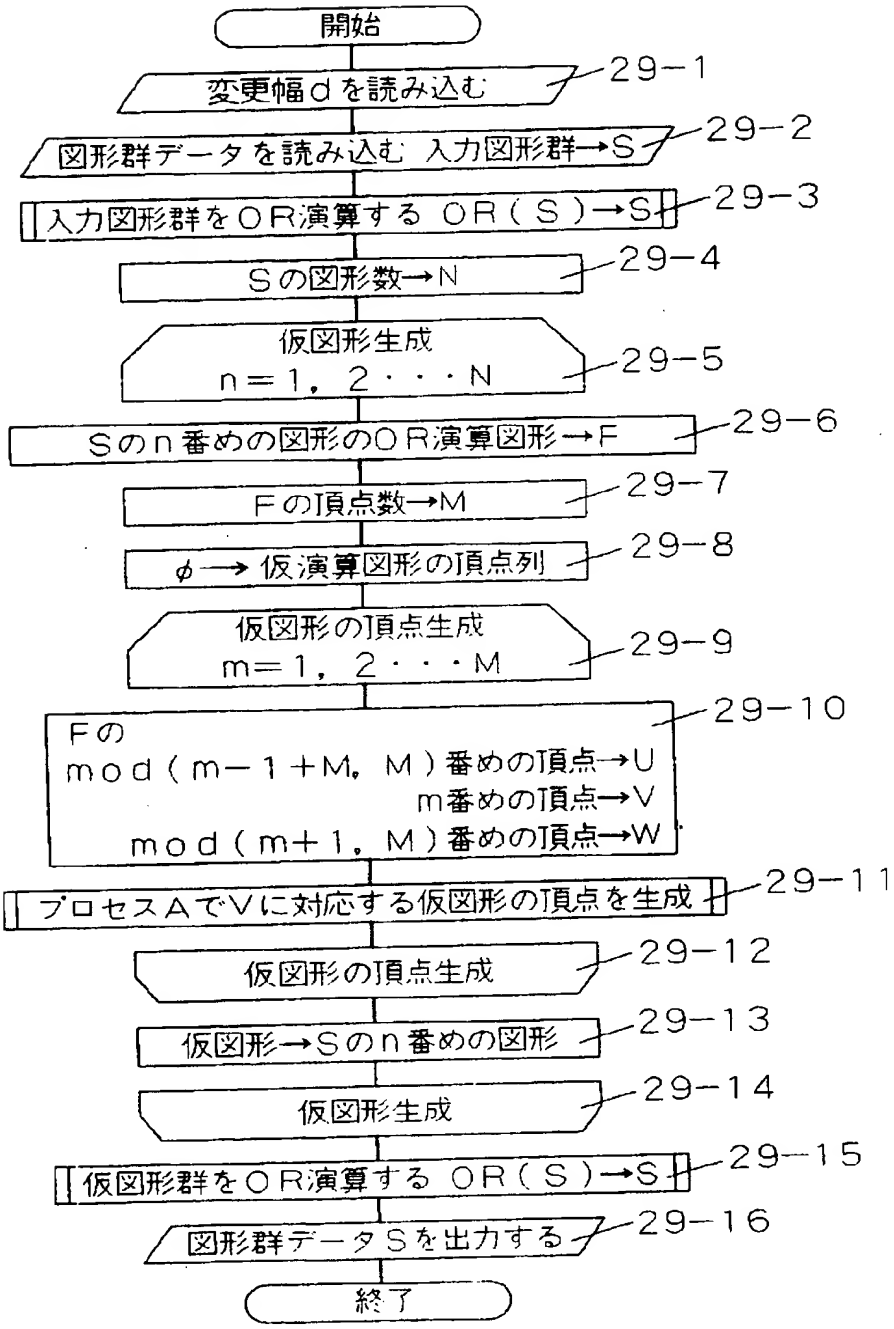
【図２８】



【図３０】



【図２９】


開始
変更幅ｄを読み込む
29−1
図形群データを読み込む 入力図形群→Ｓ
29−2
入力図形群をＯＲ演算する ＯＲ（Ｓ）→Ｓ
29−3
Ｓの図形数→Ｎ
29−4
仮図形生成
ｎ＝１，２・・・Ｎ
29−5
Ｓのｎ番めの図形のＯＲ演算図形→Ｆ
29−6
Ｆの頂点数→Ｍ
29−7
φ→仮演算図形の頂点列
29−8
仮図形の頂点生成
ｍ＝１，２・・・Ｍ
29−9
Ｆの
ｍｏｄ（ｍ−１＋Ｍ，Ｍ）番めの頂点→Ｕ
ｍ番めの頂点→Ｖ
ｍｏｄ（ｍ＋１，Ｍ）番めの頂点→Ｗ
29−10
プロセスＡでＶに対応する仮図形の頂点を生成
29−11
仮図形の頂点生成
29−12
仮図形→Ｓのｎ番めの図形
29−13
仮図形生成
29−14
仮図形群をＯＲ演算する ＯＲ（Ｓ）→Ｓ
29−15
図形群データＳを出力する
29−16
終了